# MECHANICAL ENGINEERING

• SEPTEMBER 1951 •


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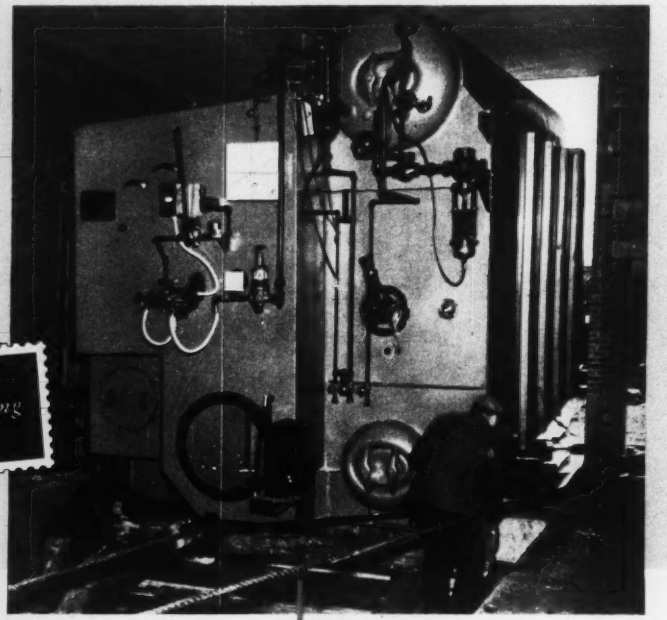
# LOOK what's here!

**NOW...** the popular B&W Integral-Furnace Boiler design available in cost-saving shop-assembled unit

*A Product of B&W Engineering for Economy*



Now, for the first time . . . all the inherent advantages of "packaged" boilers, *plus* the traditional economies of B&W's Integral-Furnace construction, are combined in a new factory-assembled water-tube unit. It's the B&W Integral-Furnace Boiler, Type FM—delivered fully equipped for immediate operation.

A modern development of the original B&W Integral-Furnace Boiler, this new unit embodies the experience gained through engineering and build-over 100 million pounds per hour of installed steam capacity to the same basic design.

Small and medium size plants, institutional and commercial establishments will find in this unit all the answers to low-cost heating and process steam-generating requirements from 2,800 to 25,000 lb. per hr. at pressures to 250 psi. Large plants, too—where space and load characteristics warrant—may profitably consider several packaged boilers as against a "tailor-made" installation.

*Helping Industry Cut Steam Costs Since 1876*

**Cost-saving features of the new B&W Integral-Furnace Boiler,**

**TYPE FM**

Saves Erection Time and Cost
Meets Wide Range of Service
Handles Quick Load Changes
Fast Steaming
Low Maintenance
Easy Accessibility
Suitable for Outdoor Service
Burns Oil and/or Gas
Saves Fuel
Saves Space
Safe, Automatic Operation

*Send for bulletin G-72, detailing the many advantages of this new B&W creation in low-cost steam generation. The Babcock & Wilcox Company, 85 Liberty Street, New York 6, N. Y.*

BABCOCK & WILCOX

G-490

# Trial by Torture

LIFE is too short to determine the useful life of our ball bearings under normal conditions. That is why we *accelerate* tests, by overspeed, overload, extremes of temperature, by running, under every conceivable condition of operation, day and night, year after year.

Around the clock, our engineers continue the research that has made the best bearings of yesterday even *better* bearings today.

Forty years of this searching have given us a wealth of experience that should be helpful to you. No need for trial and error. We've been all through that, for your benefit.

*Nothing Rolls Like a Ball...*

**NEW DEPARTURE**

**BALL BEARINGS**

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT

14V



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# Only Edward Has Integral Seats

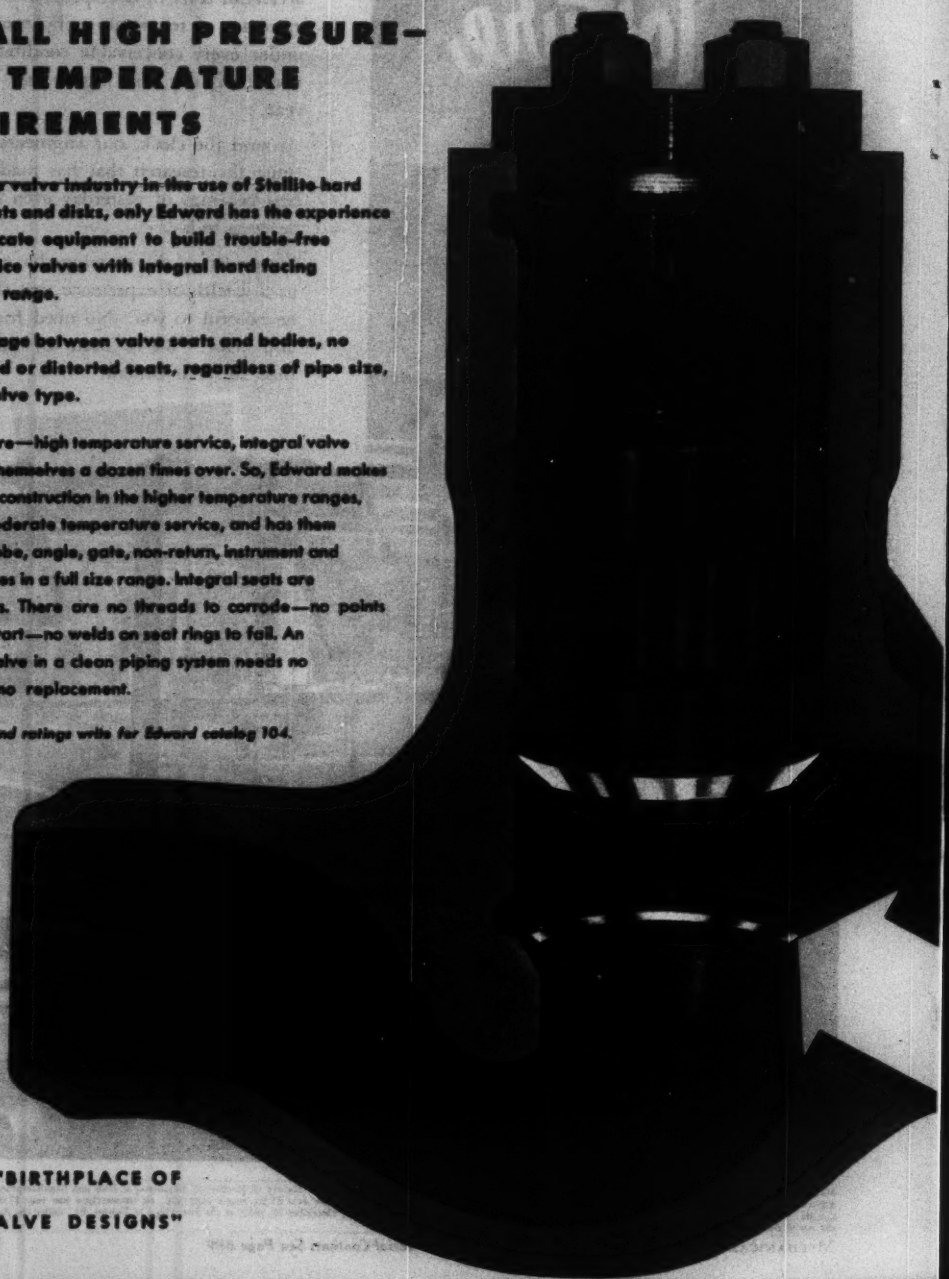
## FOR ALL HIGH PRESSURE—HIGH TEMPERATURE REQUIREMENTS

**Pioneer in the valve industry in the use of Stellite hard facing for seats and disks, only Edward has the experience and the intricate equipment to build trouble-free extreme service valves with integral hard facing in a full size range.**

**No more leakage between valve seats and bodies, no more loosened or distorted seats, regardless of pipe size, service, or valve type.**

**For high pressure—high temperature service, integral valve seats pay for themselves a dozen times over. So, Edward makes them standard construction in the higher temperature ranges, optional for moderate temperature service, and has them available in globe, angle, gate, non-return, instrument and other valve types in a full size range. Integral seats are leakproof seats. There are no threads to corrode—no points for erosion to start—no welds on seat rings to fail. An integral seat valve in a clean piping system needs no maintenance—no replacement.**

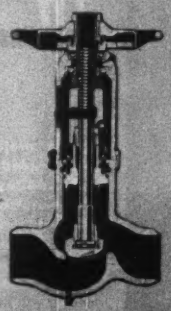
***For sizes, types and ratings write for Edward catalog 104.***



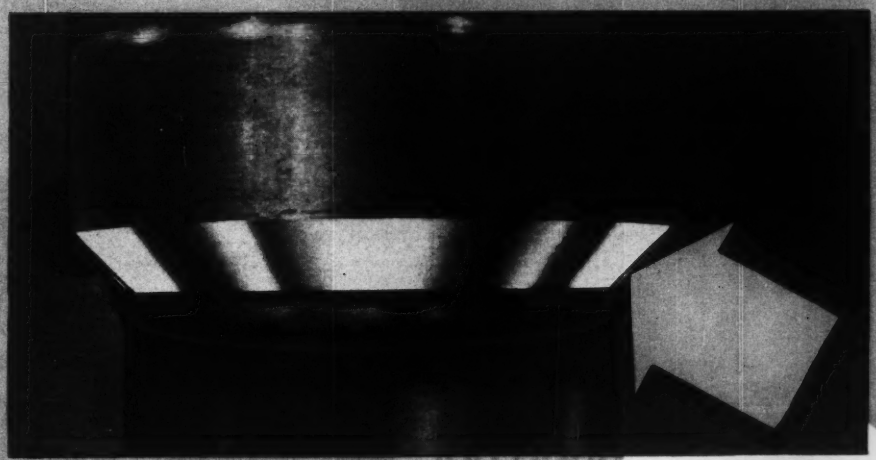
**EDWARD—"BIRTHPLACE OF BETTER VALVE DESIGNS"**

# In a Full Range of Valve Sizes

Specify Edward valves with integral, hard-surfaced seats across the board, for Edward and only Edward gives you this permanently tight, leak-proof feature in every steel valve size from ½ in. to 16 in.



**See how the Edward integral seat is part and parcel of the valve body itself. Stellite is applied by weld deposit on the machined valve body seat area. The entire body is then heat treated to remove stresses and prevent distortion. Next, the seat is machined to mirror-smooth finish and exactly mated to the hard faced disk.**



**FEATURES LIKE THIS SAVE YOU TIME, TROUBLE AND MONEY... *IT PAYS TO SPECIFY EDWARD VALVES***

***WITH AN INTEGRAL SEAT THERE ARE NO LEAKS BETWEEN SEAT AND BODY***

Another Product

## Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

1350 West 145th Street

EAST CHICAGO, INDIANA

SEDIMENTATION TANK AT 30th ST. STATION POWER HOUSE P.R.R.

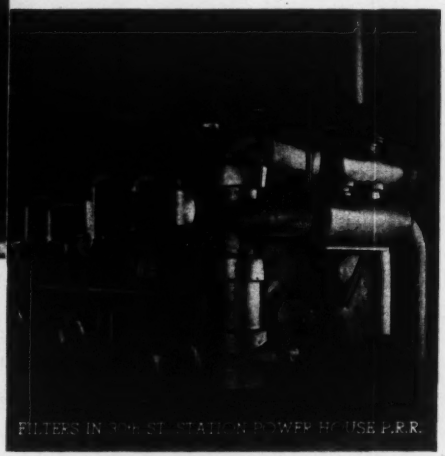
# COCHRANE Hot Process SOFTENER

## Serves a Great Railroad

ONE of the features of the huge Pennsylvania Station—30th Street, Philadelphia, of the Pennsylvania Railroad is the ultra modern power plant designed by internationally recognized architects and engineers. Recently installed in this power plant to serve additional capacity is a Cochrane two-stage Hot Process Softener for the boiler feed. It will handle 80,000 gallons per hour makeup and 10,000 gallons per hour condensate. The first stage of softening is lime and soda ash, the second stage is phosphate treatment. The water is then filtered.

Cochrane developed the hot process of softening boiler feed many years ago and has continued its leadership in the water treatment field.

Consult Cochrane on any problem involving water conditioning.



FILTERS IN 30th ST. STATION POWER HOUSE P.R.R.

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CANADIAN GENERAL ELECTRIC CO., LTD. — TORONTO

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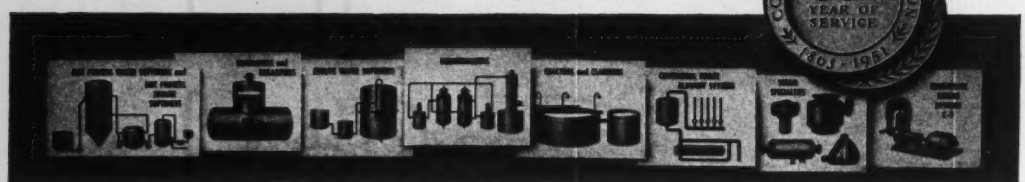
BABCOCK & WILCOX de MEXICO, S. A. — MEXICO CITY

*In Europe*

RECUPERATION THERMIQUE & EPURATION — PARIS

# COCHRANE



# THE GEARS WE MAKE FOR IS A MUST IN

THE newest HEDMAN custom model F & E CHECK PROTECTOR has been engineered to the most exacting specifications. Every component is designed and manufactured to make this the fastest, most efficient and least fatiguing Check Protector ever built! If there was ever a device in which fine, *really rugged* Fractional Horsepower Gearing is an essential requirement, *this is it!* F & E Check Protectors must perform consistently, year in and year out, with unfailing mechanical precision. That's why The Hedman Company specifies "G. S." for the Small Gearing they use. More and more of America's largest and most particular buyers are looking to G. S. for decidedly better, more uniform Small Gearing. Here you, too, can expect the kind of sincere, friendly, helpful cooperation which means so much to your business and profits. When *production runs* of custom-made Fractional Horsepower Gearing are involved—*PUT IT UP TO "G. S."!* Call us in at the drawing board stage. Let our capable engineers give ideas, suggestions and cost estimates. No obligation. Send drawings or write today!

## GET THE FREE NEW

*6-page folder which illustrates and describes G.S. facilities, Small Gearing and applications, together with handy charts, for those who specify Gearing from 12 to 96 D.P. and finer. Will you ask for it on company stationery, please?*

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GS

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Spurs · Spirals · Helicals · Bevels · Internals · Worm Gearing · Racks · Thread Grinding

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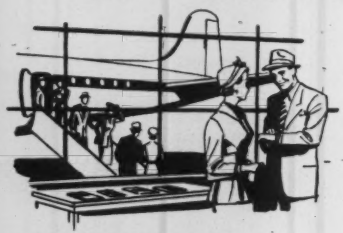
# American Blower...a time-honored name in air handling

**Birmingham, Ala.,** has a conveniently located American Blower Branch Office to provide you with data and equipment for air handling. You can reach American Blower in Birmingham by calling 7-2383. In other cities, consult your phone book.



## TEMPERATURES TAMED...

Passengers and employees alike appreciate the pleasant atmosphere created by American Blower Air Conditioning Units in a large southern air terminal. These units circulate cool, conditioned air and maintain comfortable temperatures the year round. American Blower Air Conditioning Units are widely used in commerce and industry to cool and dehumidify in summer, heat and humidify in winter. Users find this dual function by the same unit saves them money. May American Blower help you?

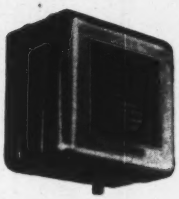
## BAKER'S DELIGHT...

A large midwest bakery recently installed several smartly styled American Blower Ventura Fans in its new, modern plant. Result—cleaner, pleasanter working conditions, improved employee efficiency. Ventura Fans maintain air circulation by exhausting hot, stale air quickly and efficiently. They are ideal for ventilating shops, factories, offices, and in many other applications. All carry Certified Ratings and are sound-rated for quiet operation. Good ventilation is good business in your plants, too.

## NOW IS THE TIME...

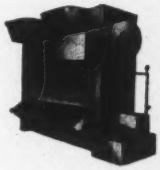
Plan now for winter heating. If your present heating system is inadequate or inefficient, replace or supplement it with American Blower Unit Heaters. These efficient Unit Heaters distribute heat evenly over a wide area, assure comfortable final temperatures everywhere. In many installations, American Blower Unit Heaters have paid for themselves in fuel savings alone within two to three years! Models for steam or hot water heating systems, also self-contained, gas-fired models.

**Whether your needs** are civilian or military, American Blower heating, cooling, drying, air conditioning and air handling equipment contributes toward improving over-all comfort and efficiency. For data, phone or write our nearest branch office.



Unit Heaters

Ventura Fans



Air Conditioning Equipment

Industrial Fans

Utility Sets

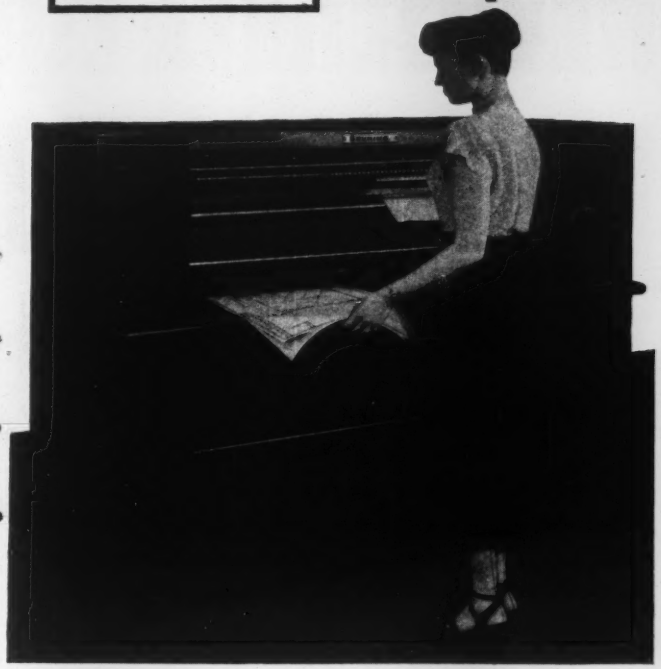
AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION

**YOUR BEST BUY AMERICAN BLOWER AIR HANDLING EQUIPMENT**

*Serving home and industry:* AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS • DETROIT LUBRICATOR • KEWANEE BOILERS • ROSS HEATER • TONAWANDA IRON

# NEW — a low-cost* whiteprinter

## ANNOUNCING BRUNING'S MODEL 20 COPYFLEX



Here's the new Bruning Model 20 Copyflex. Because of its low price, thousands of companies now can make their own whiteprints and thus realize a substantial saving. Now you can produce your whiteprints *when* you want them—as you want them.

It will pay for itself by producing sharp, clean prints of your engineering drawings as well as copying your production orders, reports, specifications, defense order copies, etc.

The Model 20 is a completely new medium volume machine of advanced design, yet sells for the lowest price of any machine in its class. It has a full 46" printing width, and takes cut or roll stock.

### *Compare these advantages*

- ***LOWEST PRICED** machine of its class available.
- **NO FUMES.** Bruning Copyflex machines use no vapor developer, therefore cannot possibly emit unpleasant fumes.
- **NO INSTALLATION.** No exhausts needed. Just connect to an ordinary 115 volt AC electric power circuit.
- **EASY OPERATION.** No training needed—anyone can operate a Copyflex.

See how the Model 20 Copyflex, or one of our other models, can help you. There is a model for every price and volume requirement. Clip the coupon now and you'll be on the road to faster, less expensive copying.

**BRUNING**

*Specialists in copying since 1897*

CHARLES BRUNING COMPANY, INC.

Dept. B-91 100 Reade St. New York 13, N. Y.

☐ Send me full details on the Model 20 Copyflex.

☐ I would like to see a Copyflex machine demonstrated.

Name_____ Title_____

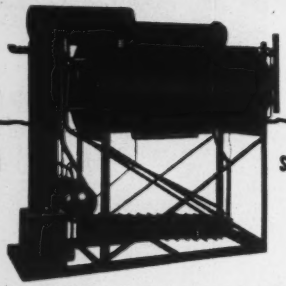
Company_____

Street_____

City_____ Zone_____ State_____

# NEW SERVEL EQUIPMENT AIR-CONDITIONING OR

## SERVEL ABSORPTION EQUIPMENT



**WATER CHILLER:** Rated capacity under standard ASRE conditions—25 tons. Hermetically sealed absorption refrigeration system. Refrigerant, water. Absorbent, lithium bromide. Source of energy, steam. Refrigeration unit operates under a vacuum

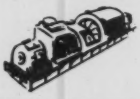
### OPERATES ON ANY OF THESE SOURCES OF STEAM

GAS-OPERATED STEAM GENERATOR

INDUSTRIAL BOILER

WASTE-HEAT BOILER

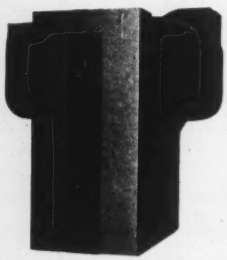
CONDENSATE STEAM GENERATOR



TURBINE EXHAUST STEAM

DISTRICT STEAM LINES

Self-Contained Unit: 5 tons of cooling, heating optional.



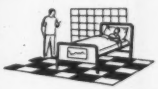
All-Year Air Conditioners. In 3-ton and 5-ton sizes. Cooling and heating. For single or multiple installation.

### SUPPLIES CHILLED WATER OR AIR CONDITIONING FOR

INDUSTRIAL PROCESSING

FACTORIES

HOSPITALS



HOTELS

SCHOOLS

OFFICES

STORES

HOMES

# SIMPLIFIES ALMOST ANY COOLING APPLICATION

- Light enough to install anywhere
- Runs on steam from any source, any pressure
- Electric-power needs are nominal
- Modulates down to 50% of capacity

NO MATTER how large or how small your cooling or air-conditioning job, the chances are that one of Servel's absorption units can do it better, easier, and at less cost.

If it's chilled water for industrial processing, or air conditioning large buildings that you're interested in, take a look at the new Servel 25-Ton Water Chiller. This latest addition to the Servel line runs on steam from any source, at any pressure. If waste steam or waste heat is available, you can operate on it and save most of the normal costs of fuel.

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For smaller areas, the Servel Self-Contained 5-Ton Air Conditioner, and the 3-ton and 5-ton units provide flexible, low-cost air conditioning. All Servel units have the famous Servel no-moving-parts cooling system. Thus you get long life, low maintenance, quiet, dependable operation.

Get complete information today. And if you'll enclose details of your process cooling or air-conditioning problems, we'll be glad to tell you which unit, or combination of units, our application engineers recommend. Servel, Inc., Evansville 20, Ind.

**WHY SERVEL IS YOUR BEST AIR-CONDITIONING BUY**

- No Moving Parts in Cooling System To Wear Out
- Low Maintenance Costs
- Hermetically Sealed Circuits
- Long Life
- Completely Safe Operation
- Chilled Water Circuit Operates Under Normal Pump Pressure
- 5-Year Factory Warranty

**SEND COUPON FOR MORE INFORMATION**

Servel

**AIR CONDITIONERS**

FOR INDUSTRY • FOR HOME • FOR BUSINESS

Servel, Inc.
Department U-29, Evansville 20, Indiana
*Gentlemen:*

Please send me more information on the following:

Servel 25-Ton Water Chiller_____
Servel Self-Contained Air Conditioner_____
Servel 3- and 5-Ton *All-Year* Air Conditioners_____

*Name*_____
*Firm*_____
*Address*_____

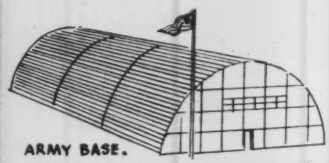
**IF YOUR JOB CAN BE DONE BETTER WITH AIR CONDITIONING OR COOLING, IT CAN BE DONE BEST WITH SERVEL**

NOTES FROM AN ARCHITECT'S SKETCH PAD

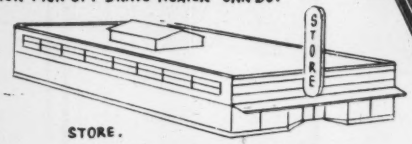
# LOOKS LIKE THAT VERSATILE DRAVO "COUNTERFLO" HEATER CAN BE USED ON PRACTICALLY ALL OUR JOBS.

SCHOOL. DISTRICT BUDGET LIMITED. CAN SAVE WITH DRAVO HEATERS.

CHURCH. INTERMITTENT HEATING. NEEDS QUICK PICK-UP. DRAVO HEATER CAN DO.



ARMY BASE.
WINTER CONSTRUCTION ON THESE BARRACKS. CAN INSTALL DRAVO HEATERS EARLY FOR HEAT DURING CONSTRUCTION AND AFTER COMPLETION.

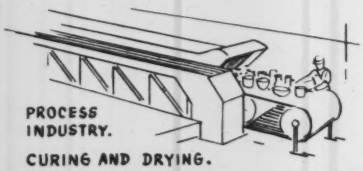



STORE.
WITH DRAVO HEATERS, CAN USE ONE SET OF DUCTS FOR HEATING AND AIR-CONDITIONING.

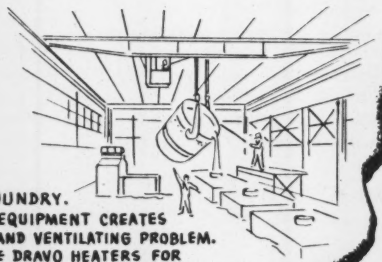
INDUSTRIAL PLANT.
DRAVO HEATERS HAVE 150' AIR THROW. NO DUCTS NEEDED.

WAREHOUSE.
HIGH CEILINGS. DRAVO HEATERS CAN REDUCE ROOF HEAT LOSS, KEEP HEAT WHERE IT'S NEEDED.

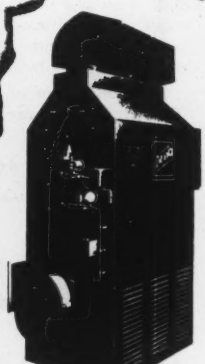
DIESEL RAILROAD SHOP.
NEEDS HEAT AT WORKING LEVEL.
DRAVO HEATERS IDEAL.



PROCESS INDUSTRY.
CURING AND DRYING.
SPECIFY DRAVO HERE.



FOUNDRY.
EXHAUST EQUIPMENT CREATES HEATING AND VENTILATING PROBLEM.
USE DRAVO HEATERS FOR TEMPERED "MAKE-UP" AIR.



...kin
...w Dravo.

A case study on any ... installations is yours for the asking. For complete information on how Dravo "Counterflo" Heaters can help solve your heating problems, write for Bulletin LM-52

**DRAVO CORPORATION**

**HEATING DEPARTMENT, DRAVO BUILDING, PITTSBURGH 22, PA.**

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Sales Representatives in Principal Cities. Mfd. and Sold in Canada by Marine Industries, Ltd., Sorel, Quebec

Export Associates: Lynch, Wilde & Co., Washington 9, D. C.

# No one speed reducer solves every reduction problem

**That's why LINK-BELT builds all 3**

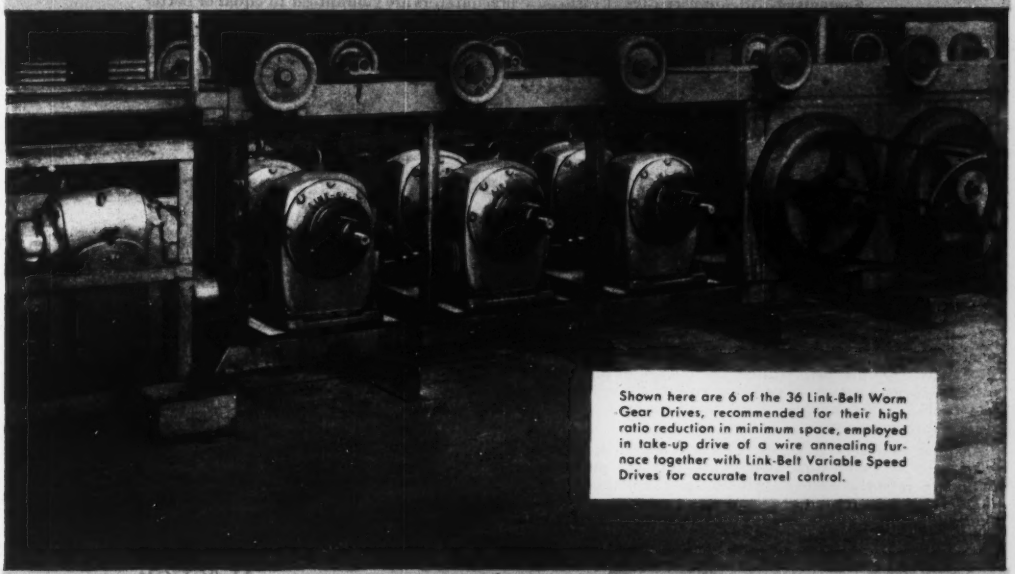
WHETHER it's a helical, a herringbone or worm gear drive that best fits your needs—you get an unbiased recommendation, an incomparable product from your Link-Belt power transmission engineer.

That's why Link-Belt builds all three; has no axe to grind. You can be sure you get the one that suits all your requirements for ratio, space, shaft position, shock loading and many other factors. Precision-engineered for quiet, economical power transmission, all Link-Belt drives will give you long service under the toughest operating conditions.

On Worm Gear Drives write for Book 2324

On Gearmotor and Helical Gear Drives write for Book 2247

On Herringbone Gear Drives write for Book 2419



Shown here are 6 of the 36 Link-Belt Worm Gear Drives, recommended for their high ratio reduction in minimum space, employed in take-up drive of a wire annealing furnace together with Link-Belt Variable Speed Drives for accurate travel control.

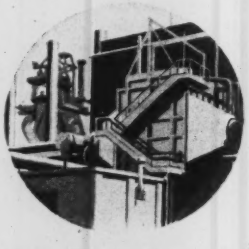
**LINK-BELT**

**ENCLOSED GEAR DRIVES**

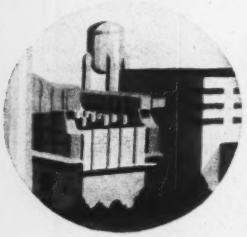
LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices, Factory Branch Stores and Distributors in principal cities.

# War on waste!

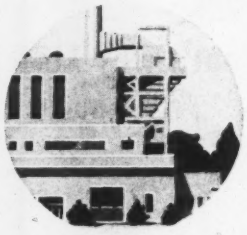
American industry is continually searching for new ways to stop waste and increase production and efficiency. A good example of this is the Koppers-Elex electrostatic precipitator. Shown below are a few typical ways industry uses them to combat waste . . .



**BLAST FURNACE GAS** must be cleaned before it can be used as a fuel. Koppers-Elex electrostatic precipitators clean this gas to residuals as low as .002 grain per cubic foot.



**FLUE GASES** from recovery boilers in pulp mills contain valuable materials. Koppers-Elex electrostatic precipitators recover several hundred thousand dollars worth of these materials yearly.



**FLY ASH** from power plants and factories may drop a blanket of dust extending three to five miles. Koppers-Elex electrostatic precipitators stop this nuisance and preserve public good will.

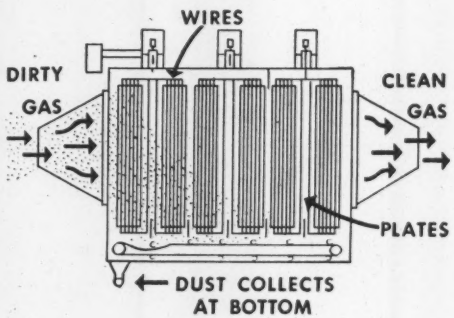
**Guaranteed:** All Koppers-Elex electrostatic precipitators are guaranteed to equal or better (under tests made by your own personnel) any efficiency or residual content you specify.

## *ENGINEERS!* You should know about these six design features of Koppers-Elex electrostatic precipitators!

KOPPERS has made sweeping improvements in electrostatic precipitator design! For example, double chambers eliminate expensive by-pass systems and the resultant loss of materials during inspection or maintenance. And re-entrainment is sharply reduced because rapping is sectionalized.

Successive collection zones are separately energized to provide maximum voltage for highest collection. And because each field is, in effect, a separate precipitator, the outage of one field *does not stop* gas-cleaning action. In addition, completely enclosed and compact "package" mechanical or vacuum tube power packs simplify installation and operation.

Another exclusive Koppers feature is the drag scraper which provides continuous dust removal, eliminates plugged hoppers and prevents bothersome dust build-up. For detailed information on recovery, gas-cleaning or nuisance abatement results write today to: Koppers Company, Inc., Precipitator Dept., 229 Scott Street, Baltimore 3, Md.

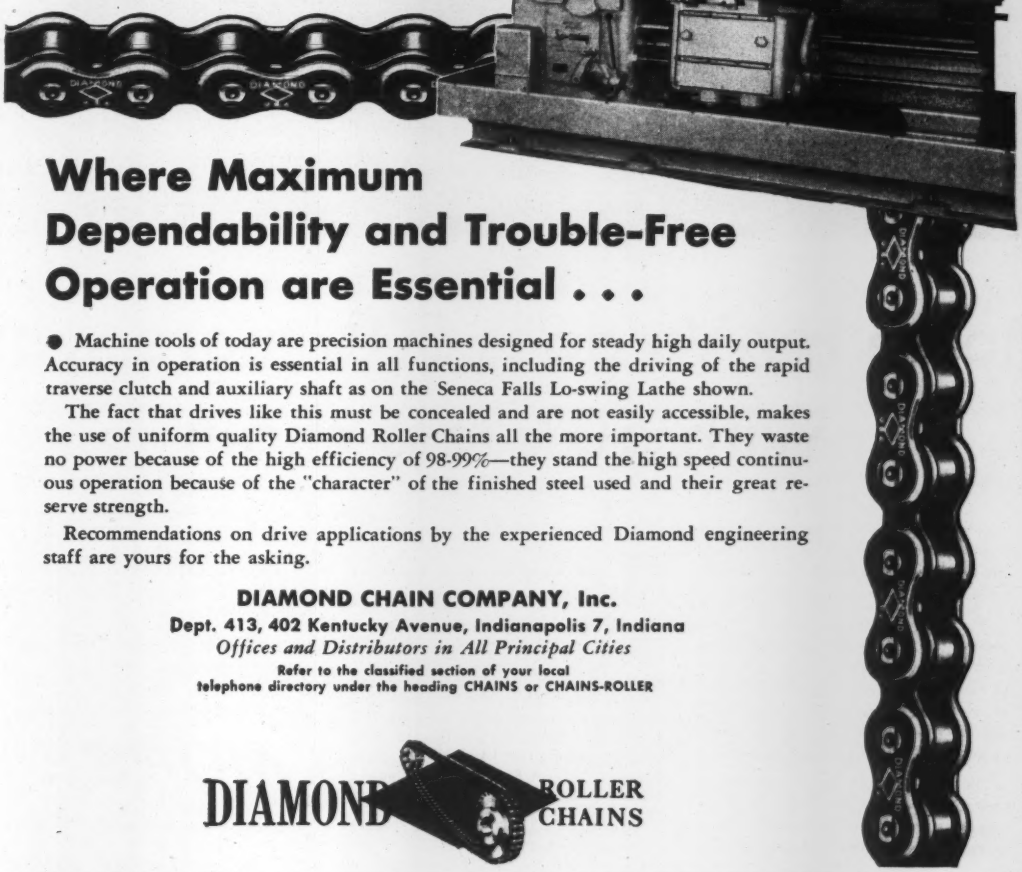



*If you have a gas-cleaning problem, write today to: Koppers Company, Inc., Precipitator Dept., 229 Scott St., Baltimore 3, Md.*

KOPPERS

Koppers-Elex ELECTROSTATIC PRECIPITATORS

DIAMOND Roller Chains



## Where Maximum Dependability and Trouble-Free Operation are Essential . . .

● Machine tools of today are precision machines designed for steady high daily output. Accuracy in operation is essential in all functions, including the driving of the rapid traverse clutch and auxiliary shaft as on the Seneca Falls Lo-swing Lathe shown.

The fact that drives like this must be concealed and are not easily accessible, makes the use of uniform quality Diamond Roller Chains all the more important. They waste no power because of the high efficiency of 98-99%—they stand the high speed continuous operation because of the "character" of the finished steel used and their great reserve strength.

Recommendations on drive applications by the experienced Diamond engineering staff are yours for the asking.

**DIAMOND CHAIN COMPANY, Inc.**
**Dept. 413, 402 Kentucky Avenue, Indianapolis 7, Indiana**
*Offices and Distributors in All Principal Cities*
**Refer to the classified section of your local telephone directory under the heading CHAINS or CHAINS-ROLLER**



DIAMOND ROLLER CHAINS

Morse **HY-VO** Drive for a new age in power transmission

# Morse Hy-Vo does 50% more work with 50% less chain

A *200-kilowatt* generator on the Standard Dredging Company dredge boat "Diesel" requires a 12"-wide silent chain drive.

When an additional generator was needed, the boat owners turned to Morse Hy-Vo (above). Result? The new *300-kilowatt* generator is driven by a 6"-wide Hy-Vo Drive. That's 50% more work with 50% less chain—and another application that Hy-Vo takes right in stride.

The Morse Hy-Vo Drive gives up to one-third longer service life, cuts operating costs per hour up to 50%. Morse Hy-Vo transmits more horsepower at greater speed (up to 5000 HP at 1200 RPM) and lower cost than any other standard drive.

### New age in power transmission

Hy-Vo permits the transmission of vastly increased horsepower from smaller, less expensive, high-speed engines and motors—without costly accessories. Hy-Vo is the latest addition to a complete line of products that has made the name Morse a byword for the best in power transmission equipment and engineering.

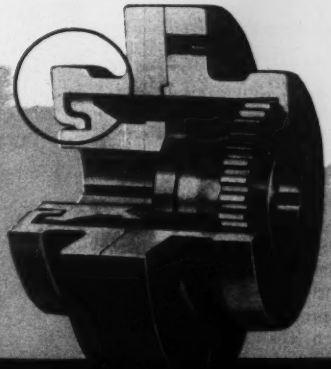
Write today for Hy-Vo Catalog C 72-51—or for information on Morse Silent Chain or Roller Chain Drives, Morse Flexible Couplings, Morse Drive Shafts, or Morse Clutches. (Hy-Vo orders must carry priority rating at present time.)

More than ever, M=PT—Morse means Power Transmission.

**MORSE**
MECHANICAL
*POWER TRANSMISSION*
PRODUCTS

**MORSE CHAIN COMPANY • Dept. 200 • 7601 Central Ave. • Detroit 8, Mich.**

# NEED "SPECIAL" COUPLINGS?



## Koppers Can Help You Save Money With *Easily Modified*

# STANDARD Fast's Couplings

**FOOLPROOF DESIGN:** Instead of perishable oil seals, Fast's use a permanent metal-to-metal closure. Oil is always maintained at a safe level, whether the Fast's is running or standing still!

**LOWEST COST:** Fast's Couplings cost less per year because they normally outlast the equipment they connect. Original cost can be divided by 20 years or more. As one user says: *"We've had this Fast's Coupling since 1930 . . . it's apparently going to last forever!"* (Name on request.)

**NEW DEVELOPMENTS:** Fast's were the first gear-type couplings on the market. And they're first again with new designs developed by Koppers—like the revolutionary new Breaking Pin Coupling now available.

IF YOUR coupling problem looks tough—specify Fast's. Then Koppers' engineers can go to work, study your problem, and in many cases find a special coupling is not needed at all. Instead, these coupling specialists can often modify a *standard* Fast's Coupling and save you important money!

Standard Fast's Couplings can be modified for hundreds of unusual applications. Records kept over the past 31 years prove that Fast's Couplings outlast the equipment they connect. Fast's still maintains its original design, without basic change or sacrifice in size or materials.

Don't take chances. Whether your application calls for special or standard couplings, specify Fast's. For full information and specifications, write for your copy of Fast's free catalog today!

KOPPERS

**FAST'S**

THE ORIGINAL GEAR-TYPE

**Couplings**

INDUSTRY'S STANDARD FOR 31 YEARS

*Mail* COUPON TODAY FOR FREE CATALOG!

KOPPERS CO., INC., *Fast's Coupling Dept.*,
259 Scott St., Baltimore 3, Md.

*Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.*

Name.....

Company.....

Address.....

City.....Zone.....State.....

## A Lot of Dependability in a Small Package

Thousands of industrial firms recognize the Cuno AUTO-KLEAN disc-type strainer as an indication of *protection* on lube and hydraulic systems.

They know the machine builder has provided the best means of keeping fluids *clean* . . . when he has installed the AUTO-KLEAN as standard equipment.

They appreciate, too, the ease with which the AUTO-KLEAN works. A turn of a handle—periodically by hand or continuously by automatic means—is all that is necessary to keep the strainer *itself* clean. This is done without stopping flow. And there's nothing to replace or renew.

They also know that the AUTO-KLEAN is *guaranteed* to remove 100% of the solids larger than specified*. . . with minimum pressure drop.

## The Favorite of Designers

The Cuno AUTO-KLEAN solves other problems *right on the board.*

It's compact. A single unit handling full flow (from a few to more than 4000 gpm) occupies no more space than the usual partial-flow type.

You can build it in—or mount it externally. Inlet and outlet can be in any position. You can install it on low pressure or gravity feed or suction with no loss of efficiency.

And you can depend upon it lasting as long as the equipment on which it is installed because it is all-metal and non-collapsible and can be made of a wide range of materials for various fluids, viscosities, temperatures and solids to be handled.

*Available spacings from .0035 in. to .062 in.

Cuno Engineering Corporation
Dept. 651 A, South Vine St., Meriden, Conn.
Please send information on Cuno AUTO-KLEAN
for .....
Name .....
Company .....
Address .....
City .....Zone....State....
Please attach to business letterhead

# You Can Clean This Fluid Strainer Without Stopping the Flow

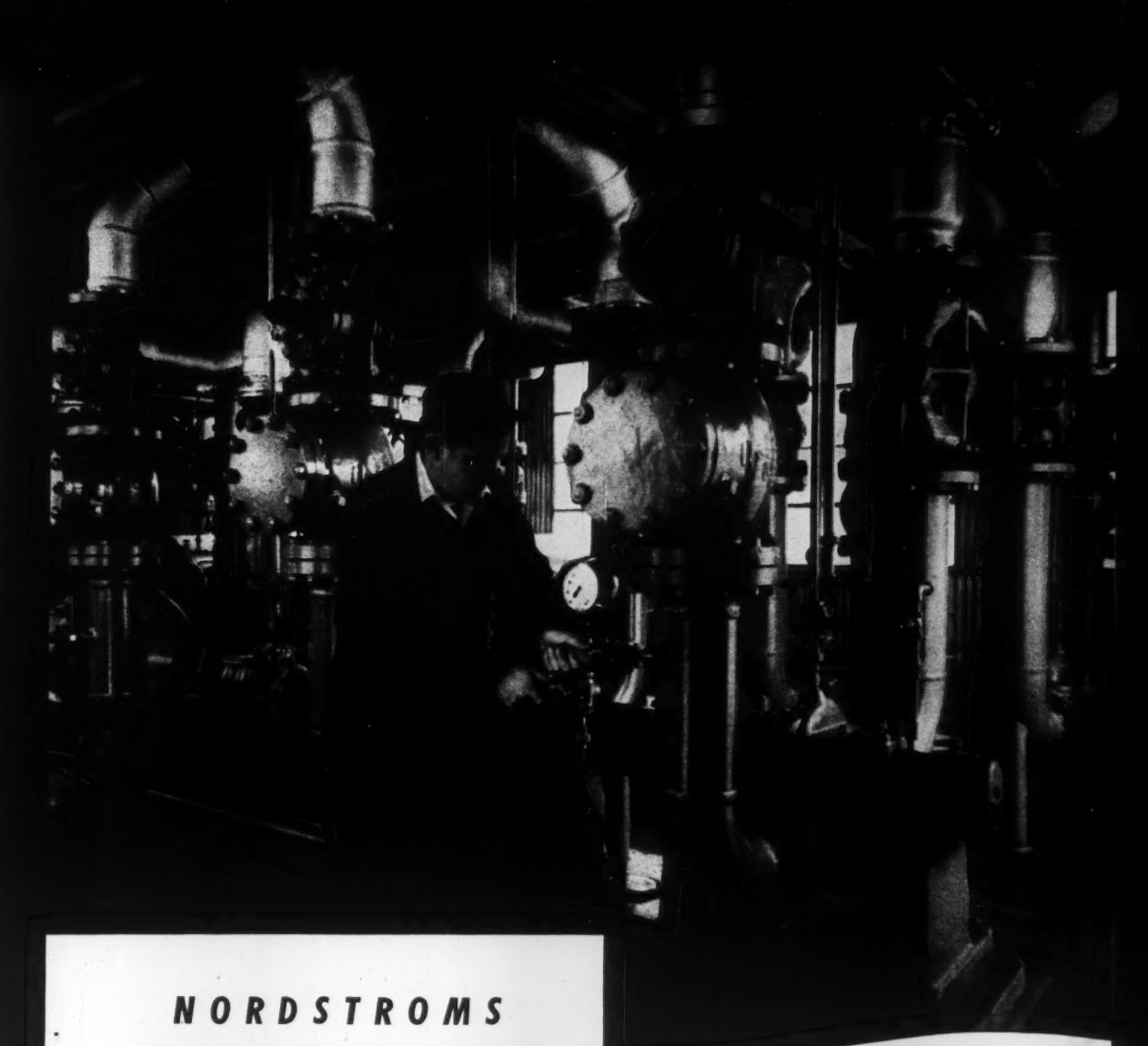
Cuno AUTO-KLEAN is the *only* fluid strainer with "comb-action cleaning" which permits it to work uninterruptedly. Dirt accumulations are dislodged *while* the straining goes on. This can be done automatically. *Guaranteed* to remove 100% of all solids larger than specified.

CUNO

*Fluid Conditioning*

**Removes More Sizes of Solids from More Kinds of Fluids**

**Strain** fuels, lubricants, process fluids, etc.—AUTO-KLEAN
**Filter** fuels, lubricants, process fluids, etc.—MICRO-KLEAN
**Clean** raw water, recirculating water, etc.—FLO-KLEAN



# NORDSTROMS

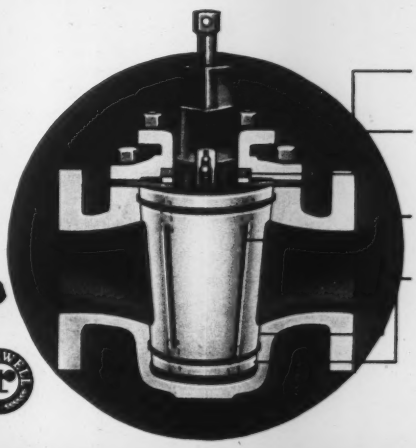
## BELONG IN YOUR PUMP HOUSE

Insure most dependable operation in controlling flow of all liquids, chemicals, gases, hydrocarbons, slurries and solutions—hot or cold—at any pressure

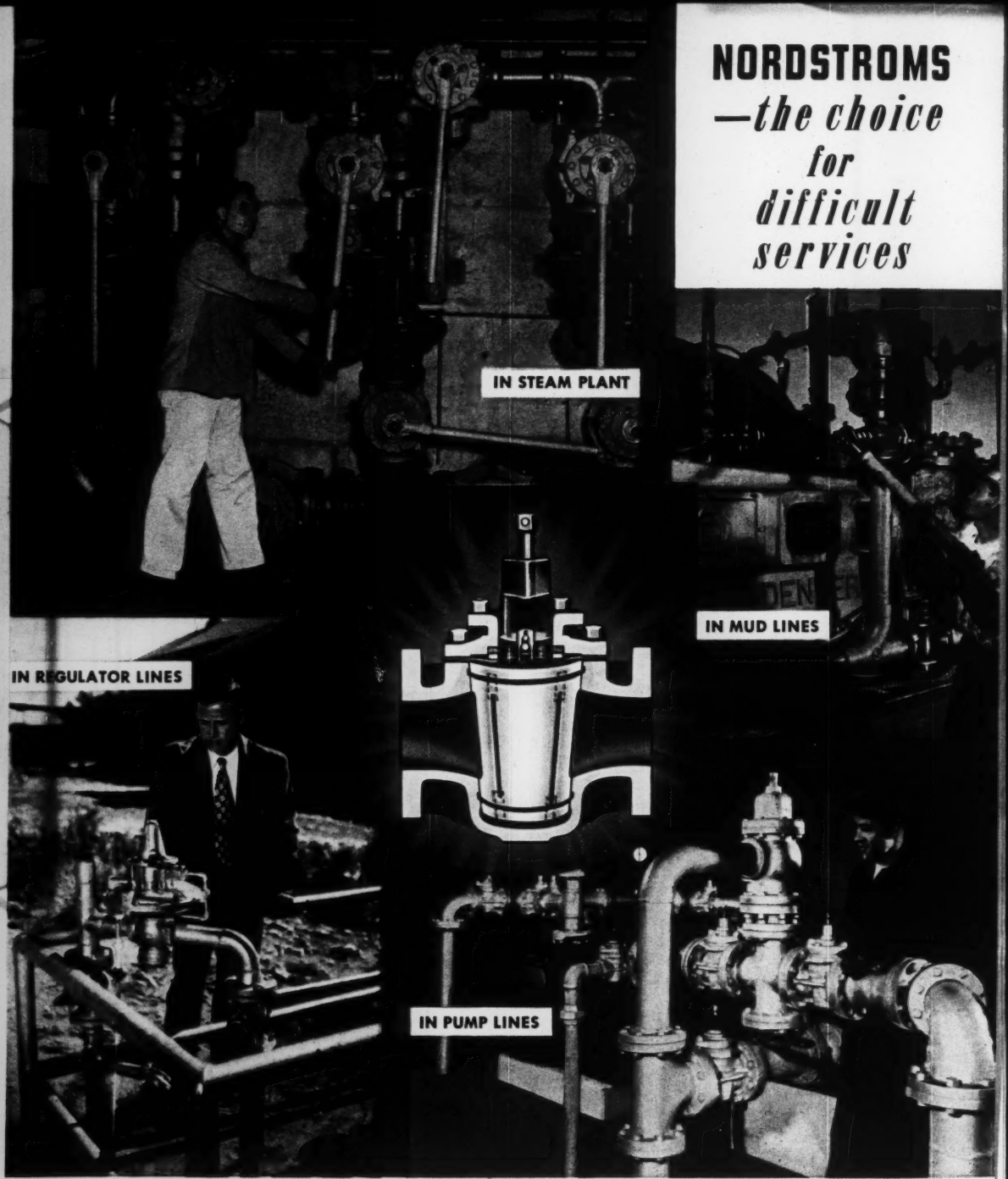
**Nordstrom**

**VALVES... NOW AUTOMATICALLY LUBRICATED**

WITH Trade Mark Hypermatic Pats. Applied for



# NORDSTROMS
## *—the choice for difficult services*

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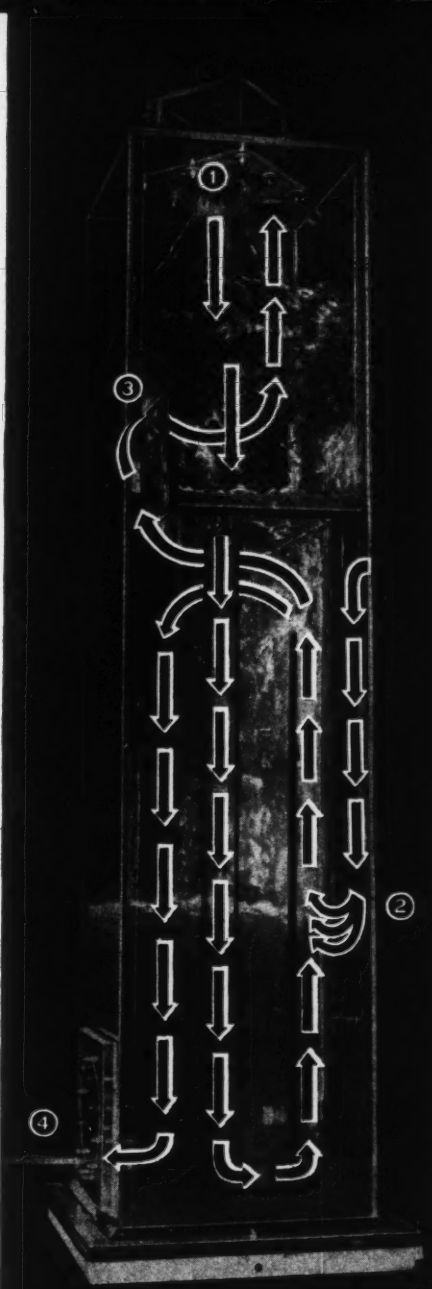
Atlanta, Boston, Chicago, Columbus, Houston, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco, Seattle, Tulsa . . . and leading Supply Houses. Export: International Division, Rockwell Manufacturing Company, 7701 Empire State Building, New York 1, N. Y.

# ONE LOOK IS WORTH 1,000 GUESSES . . .




## *See for Yourself How the*

# PERMUTIT DEAERATOR

## *Removes All Oxygen and $CO_2$*

This transparent model of Permutit's Deaerating Heater is a perfect picture of the operating ease and efficiency of the real unit it represents. Here are a few of the reasons why many engineers call it the best equipment for deaerating boiler-feed make-up water:

The Permutit Deaerator recovers waste heat economically, prevents corrosion of feed lines, stage heaters, economizers, and boilers, and is itself corrosion-free. It operates noiselessly and is adaptable to varying steam pressures. Above all, its simplicity of design insures a minimum of expense and attention for maintenance.

Write for full details to The Permutit Company, Dept. ME-9, 330 West 42nd Street, New York 18, N. Y., or to the Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal.

**1.** FIRST STAGE. Cold water, entering here, is heated almost to steam temperature by *spraying* it through steam. This removes 95% of the oxygen. The water then travels downward through the pipe toward the second stage.

**2.** SECOND STAGE. Here the partially deaerated water is intimately mixed with steam entering through the scrubber. Violent boiling and vigorous scrubbing is assured for both light and heavy loads, and deaeration is completed.

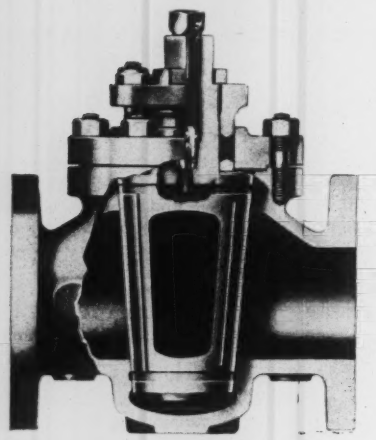
**3.** The steam from the scrubber travels upward and enters the first stage of the heater, where it partially deaerates incoming water. The remaining steam is then vented to the atmosphere.

**4.** Here the completely deaerated water settles and may be drawn off. Ample water storage space is provided below the water control level.

Water Conditioning Headquarters for Over 38 Years

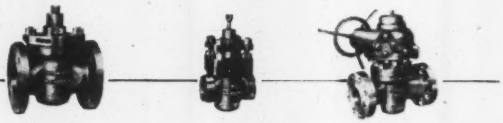
**PERMUTIT**

# WALWORTH
# Lubricated
# Plug Valves



## *for TOUGH assignments*

***where tight shut-off...***
***and easy operation***
***are "MUSTS"***



### Walworth Lubricated Plug Valves Offer These Advantages

- Complete surrounding of ports with resistant lubricant affords positive seal against leakage.
- Lubricant grooving system assures ease of operation — tight shut-off — greater protection against corrosion.
- Body and plug fully protected by lubricant from attack by line fluids.
- Quarter turn opens or closes valve.
- Made in a complete range of sizes ½" to 26" and for pressures from 175 to 5,000 psi., and for vacuum requirements.

For handling petroleum products, natural or manufactured gas, acids, alkalies, solvents, slimes, slurries . . . in fact for almost any hard-to-handle liquids—there's a Walworth Lubricated Plug Valve designed for the job.

Easy to operate, tight sealing, resistant to wear and corrosion, Walworth Lubricated Plug Valves assure long years of dependable service at low operating cost.

Walworth Lubricated Plug Valves are available in sizes ½" to 26" for pressures from 175 to 5,000 psi., and for vacuum requirements. For full details—prices, sizes, dimensions, and other pertinent data, see your Walworth distributor or write to:

# WALWORTH

**valves • fittings • pipe wrenches**

**60 EAST 42nd STREET, NEW YORK 17, N. Y.**

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

**WELDING HERCULOY** *plates into a hot water storage generator for the new Veterans' Hospital in Boston.*

**ROLLING HERCULOY** *plates into cylindrical form for the tanks. Photos from The Patterson-Kelley Co., Inc., East Stroudsburg, Pa.*

Once Again—

# HERCULOY

## is Chosen for Hot Water Storage Generators

**HERCULOY** is Revere's Copper-Silicon Bronze, which has the corrosion resistance of copper plus the strength of mild steel. It is therefore ideal for hot water tanks, among many other applications. Much has gone into domestic water heaters, but these are far outstripped in size by a number of large tanks fabricated of Herculoy by The Patterson-Kelley Co., Inc., East Stroudsburg, Pa., for the new Veterans' Hospital in Boston. The water is heated by steam passing through bundles of Revere Phosphorized Copper Tube. Inlet and outlet flanges are Herculoy, made from heavy gauge extruded shells, which offer economies over the alternative method of cupping them out of plate.

Patterson-Kelley weld all these large storage heaters, using Heliarc. Easy weldability is another important quality of Herculoy. Golden beauty is also a feature, and the size and beauty of these tanks created a great deal of comment while they were being trucked to the hospital. . . . Remember Herculoy's qualities: corrosion resistance of copper, strength of mild steel, easy weldability and formability, and beauty. Remember other applications besides tanks, such as: vats, screens, filters, ducts, fire extinguishers, chemical and marine construction.

**REVERE** 150th YEAR OF SERVICE TO AMERICA

**COPPER AND BRASS INCORPORATED**

*Founded by Paul Revere in 1801*

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*Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.— Sales Offices in Principal Cities, Distributors Everywhere*

**SEE "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY**

# Designer's

## MOTOR MOUNTINGS FOR EVERY MACHINE

### —to simplify your design job!

One of the big time-saving advantages of Tri-Clad induction motors for designers today is the wide variety of motors and motor modifications available in the line. You can literally specify one for almost every conceivable type of mounting —usually right out of the catalog—that will simplify your design job, save space, and cut assembly costs.

This versatility of mounting is basic with both the open (drip-proof) and the popular totally enclosed lines, each comprising a wide range of ratings. Where the motor is to become a part of your machine, a Tri-Clad motor mechanical modification—like the few shown below—can improve appearance, add convenience, and save space and weight.

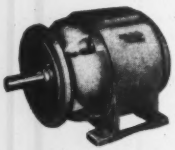
And because they're all Tri-Clad motors, you have industry-proved 3-way extra protection—against physical damage, electrical breakdown, and operating wear and tear. For the "inside story" on Tri-Clad motor toughness, see Bulletin GEA-3580.

**Standard motors** can be foot-, sidewall-, or ceiling-mounted for a wide variety of applications. Wherever they can be used, they are less expensive and can be shipped sooner than special motors. Installation is quick and easy, and they can often be shifted from one job to another in an emergency.

**TRI CLAD**
REG U.S. PAT. OFF.

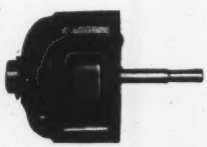
**INDUCTION MOTORS**

**Face-type motors** are used where motor supports machine, by means of bolts which screw into tapped holes in motor's end shield. Supplied with or without feet.



**Flange-type motors** are for use where machine supports motor, attached by bolts tightened from motor side of end shield's mounting surface. Supplied with or without feet.

**Vertical motors** are for direct coupling to vertical machine shafts. The Type P base conforms to NEMA standard dimensions.



**Partial motors,** built right in or closely coupled to the machine, are supplied less one or more components—end shields, bearings, shaft.

**GENERAL ELECTRIC**

# Digest

PRODUCT HIGHLIGHTS

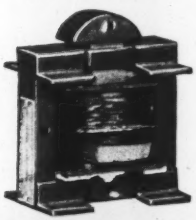
## MANUAL SWITCHES
—for simplest motor-starting!

As easy to use as a home light switch is this General Electric manual motor-starting switch. Available with overload protection in both push-button and toggle-operated types, it's the simplest way to control infrequently started small motors. Mounting and wiring are simplified, too, because of front-connected terminals, easy-to-reach knockouts, roomy case. For 1 to 7½ hp, 1-, 2-, or 3-phase a-c motors, or for d-c motors up to 2 hp. See Bulletin GEA-1522.

## SWITCHBOARD INSTRUMENTS
—long scale and shadow-proof!

Newly designed shadow-proof covers on these G-E long-scale switchboard instruments now make possible quick, accurate readings even under sharp-angle lighting conditions. They are enclosed in dust-tight, moisture-resistant cases designed for semi-flush mounting and reduced behind-the-panel depth. You can obtain these shadow-proof instruments as ammeters, voltmeters, and wattmeters; frequency and power-factor meters; temperature indicators and synchroscopes in either 4¼- or 8¾-inch sizes—all accurate to ±1 percent. See Bulletin GEC-218B

## HEAVY-DUTY SOLENOIDS
—for precision push or pull!



When your machine needs a straight-line push, pull, or reciprocating motion, you'll get a reliable, precision job with General Electric heavy-duty solenoids. Designed especially for long life in industrial service, they're available in a complete line, continuously rated, for a-c or d-c. Ratings range from a ¾-inch stroke at 0.65-lb thrust to 3-inch stroke with a thrust of 97 pounds. Ratings and full description, plus condensed data on how to select a solenoid, are contained in Bulletin GEA-5163.

**Wall-mounted type** (above) comes in ratings from ¾ to 7½ kw.

**Floor-mounted type** (right) is available in 10- to 25-kw ratings.

# NOW...

## PACKAGED METALLIC-RECTIFIER POWER SUPPLIES

*. . . for easy specifying, fast installation, low maintenance, flexible operation!*

Here is a line of packaged a-c to d-c conversion units that's easier to specify and install, lowers unit costs, and speeds shipments. Made up of standard subsections, unit comprises selenium rectifier stacks, insulated transformer with taps to adjust for 10 per cent line voltage variation, and optional auxiliary control—all mounted in a metal enclosure. For flexibility or added capacity, two or more units can be placed in series or in parallel. Absence of moving parts (except for fan-cooling in larger units) cuts need for maintenance. See new Bulletin GEA-5658.

**General Electric Company, Section F 668-90**
**Schenectady 5, New York**

Please send me the following bulletins:

- ☐ for reference purposes
- ☐ in connection with immediate projects

- ☐ **GEA-1522 Manual motor-starting switches**
- ☐ **GEA-3580 Tri-Clad induction motors**
- ☐ **GEA-5163 Heavy-duty solenoids**
- ☐ **GEA-5658 Metallic-rectifier power supplies**
- ☐ **GEC-218 Switchboard instruments**

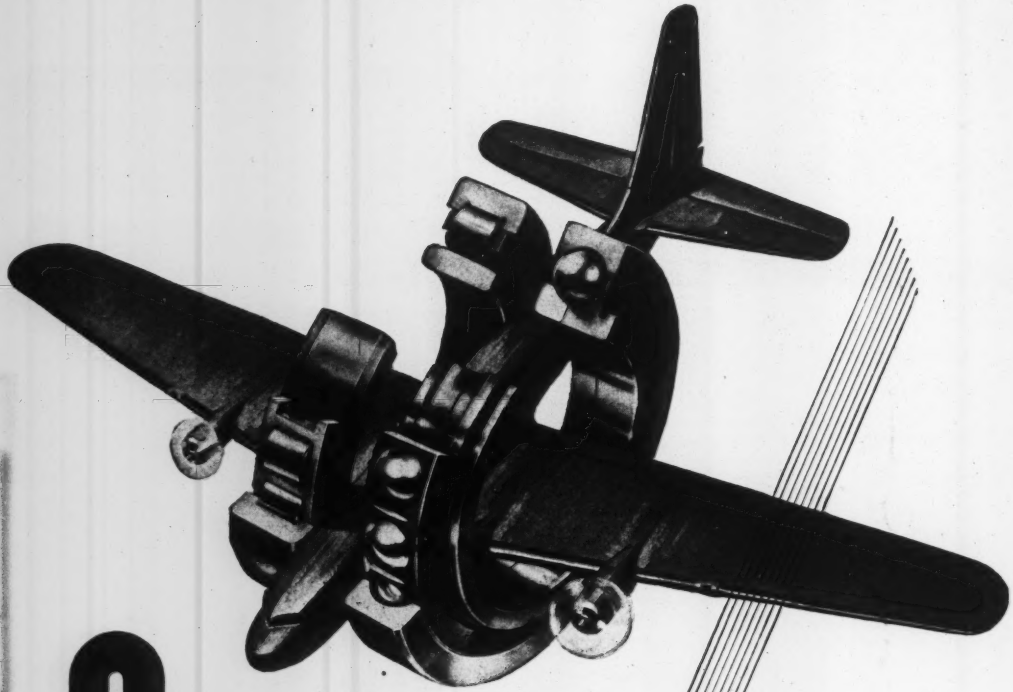
CONSULT YOUR McGRAW-HILL ELECTRICAL CATALOG FOR PRODUCT ENGINEERS! You'll find "everything electric" for machinery manufacturers in the General Electric section.

NAME_____

COMPANY_____

STREET_____

CITY_____ STATE_____



9/10

**The engine manufacturers who produce approximately nine-tenths* of the power for AMERICA'S aircraft use SKF BEARINGS.**

This, again, is typical of the acceptance of **SKF** Bearings by *all* industry—acceptance which has been built on confidence in **SKF**'s ability to help industry put the right bearing in the right place. 7165

8 REASONS WHY SKF IS PREFERRED BY ALL INDUSTRY

- integrity
- craftsmanship
- metallurgy
- tolerance control
- surface finish
- product uniformity
- engineering service
- field service

**SKF**
BALL AND ROLLER BEARINGS

**SKF** INDUSTRIES, INC., PHILADELPHIA 32, PENNA.
*-manufacturers of* **SKF** *and* HESS-BRIGHT *Bearings.*

* 1950 Estimate by "Aviation Week".

## Just a Corner of the World's Largest Line

Illustrated above are the stock sizes of long-radius WeldELLS in a single weight and material. Multiply this group by all the weights, all the types and all the materials, and you have the world's largest line of forged fittings for pipe welding.

The Taylor Forge line grew to this size because nothing less could meet the demand for fittings of Taylor Forge design, quality, accuracy, uniformity.

Make this your final reason for insisting on the WeldELL line for every fitting and flange requirement. Coupon brings new data sheet described below.

# TAYLOR FORGE

**TAYLOR FORGE & PIPE WORKS** • General Offices and Works: P. O. Box 485, Chicago 90, Ill.
*Offices in all principal cities* • Plants at: Carnegie, Pa.; Fontana, Calif.; Hamilton, Ont. Canada

TF

**A volume of data on a single sheet**

Data on welding fittings and flanges condensed on two sides of a durable, varnished, letter-size card. Particularly useful for the pipe designer. Coupon brings your copy.

Send one of your fitting and flange sheets to:

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POSITION_____

COMPANY_____

STREET ADDRESS_____

CITY_____ ZONE____ STATE_____

Mail to Taylor Forge & Pipe Works, P. O. Box 485, Chicago 90, Ill.

504-0951

SATISFACTION-RIGHT TO THE ENDS
GIBSON-SPRINGS
The William D. Gibson Co.

# One VU can start a family

With fuel costing what it does today, it is more important than ever before to select a boiler that will assure the most efficient performance possible. That is why so many companies who watch steam costs closely have acquired sizeable families of Vertical Unit Boilers. For example:

**A Chemical Company** ordered two VU Boilers in 1939. In 1946 five more were ordered for three of their other plants. In 1949 another was ordered for one of these same plants, and in 1950 two more units for a fifth plant. In 1951 three more units were ordered for still another plant — thirteen units for six plants in twelve years!

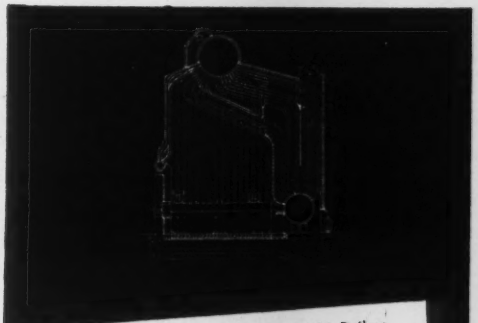
**An Electric Utility Company** ordered its first VU in 1941. In 1945 it ordered a second VU for a different plant. For another of its plants one unit was installed in 1946 and two more in 1947. In 1949 a VU was installed in a fourth plant, and in 1950 one was installed in a fifth plant. A total of seven boilers in five different plants.

**A Sugar Company** ordered two VU Boilers for one of its plants before the war. In 1946 it ordered a VU for a second plant. And in 1950 another VU was installed in this same plant.

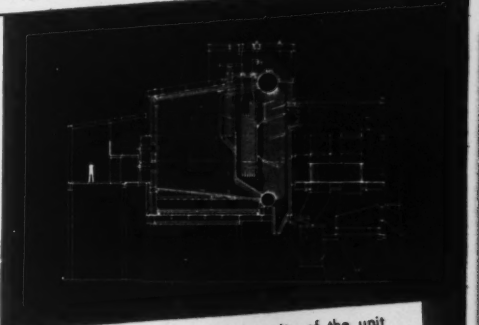
**A Steel Company** now has a total of fourteen VU Boilers in four different plants. Starting with an installation of two units in the early thirties, it has reordered six times. The most recent installation of two units at one of its plants was completed in 1948.

* * *

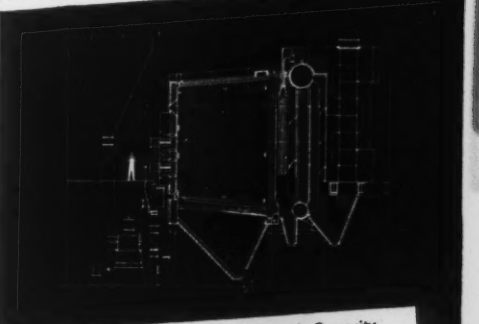
This is just a small sample of the hundreds of companies that have ordered and *reordered* the VU Unit. They have found *through their own experience* that the advanced design, sound construction and consistent reliability of the VU Unit mean *lower steam costs.* Once you have a VU in service you soon know why it is that so often *one* VU starts a family. B-494A



**VU-10 Boiler** fired with oil or gas. VU-10 Boilers range in capacity from 10,000 to 60,000 lb of steam per hour. They may also be fired by spreader, underfeed or chain grate stokers.



**VU-50 Boiler** fired with oil. Capacity of the unit shown is 235,000 lb of steam per hour; operating pressure—920 psi; steam temperature—905 F. Unit arranged for future pulverized coal firing if desired.



**VU-50 Boiler** fired with pulverized coal. Capacity of unit shown is 150,000 lb of steam per hour; operating pressure—625 psi; steam temperature—760 F. C-E Tubular Air Heater follows the boiler.

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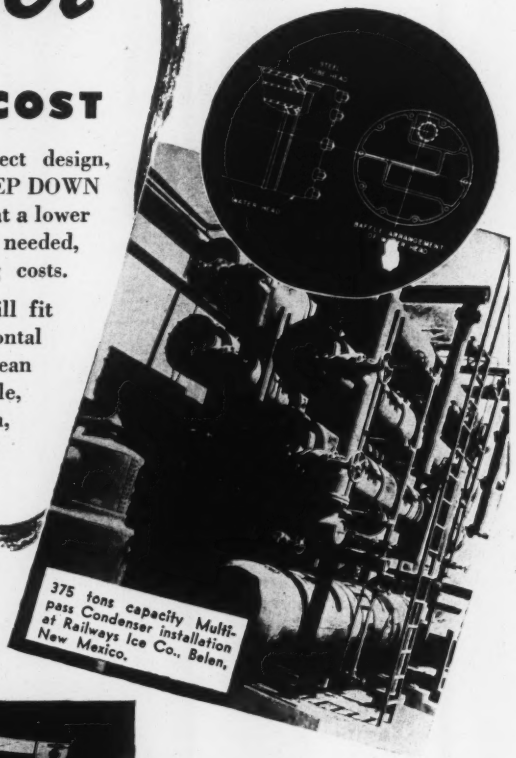
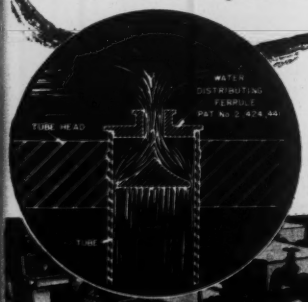
**Horizontal Multipass Condensers**
(Closed Type)

Water circulated in tubes traverses the length of the unit a number of times as determined by baffles in the heads.



375 tons capacity Multipass Condenser installation at Railways Ice Co., Belen, New Mexico.

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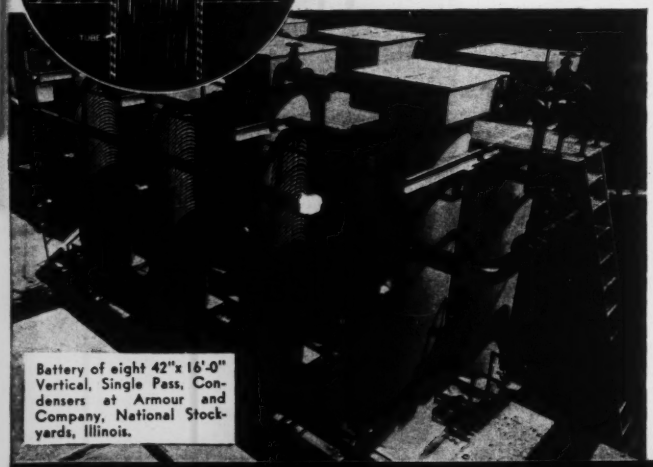

Battery of eight 42"x 16'-0" Vertical, Single Pass, Condensers at Armour and Company, National Stockyards, Illinois.

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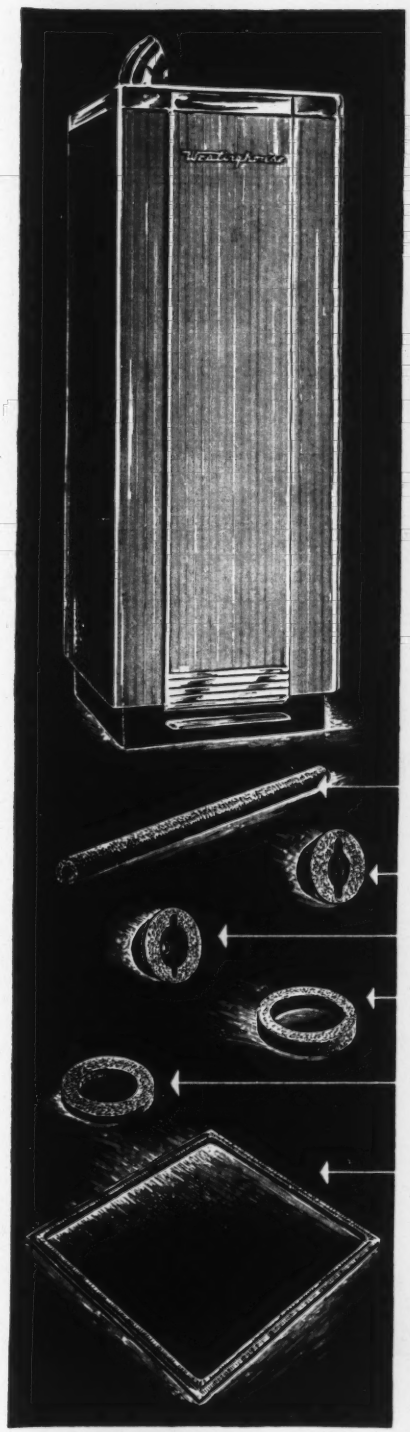

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*has a Longer, Better Life... works less each day*

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*Regulator valve cap—*
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*Water valve cap—*
covers shut off valve controlling water flow to bubbler.

*Basin drain insulator—*
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*Basin drain seal—*
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16 TESTS

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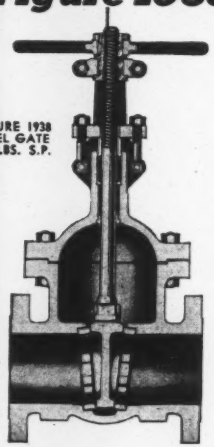
### *Figure 1938*

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*The functions of the cathode-ray oscillograph in this hydraulic application are but typical of the diversity of fields in which it is finding more and more important uses.*

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**CONSERVE MANPOWER** by automatically performing the many routine repetitive adjustments.

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ON BOTH PROPORTIONAL AND RESET RESPONSES

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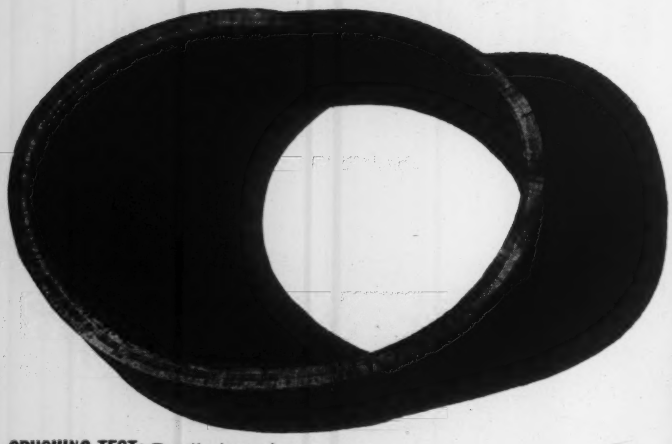
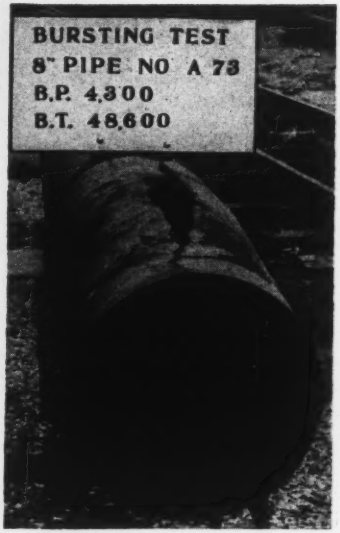


**CRUSHING TEST:** Ductile iron pipe sections, tested to fracture in compression, reveal the superior ductility of this new engineering material. Its strength and toughness make ductile iron an excellent material for tubular products. The average ring modulus of rupture on 8" diameter rings so tested by Underwriters Laboratories was 127,650 p.s.i. Photographs shown here were furnished by Lynchburg Foundry Company, Lynchburg, Va.




**BURSTING TEST:** This 8" diameter pipe was cast in ductile iron, welded with Ni-Rod 55® (nickel welding rod developed for cast iron) and then subjected to bursting tests. Average internal bursting pressure: 4,300 lbs. Average bursting tensile strength: 48,600 p.s.i. All cracks occurred outside of the weld, with no shattering.

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# MECHANICAL ENGINEERING

*Published by The American Society of Mechanical Engineers*

VOLUME 73 NUMBER 9


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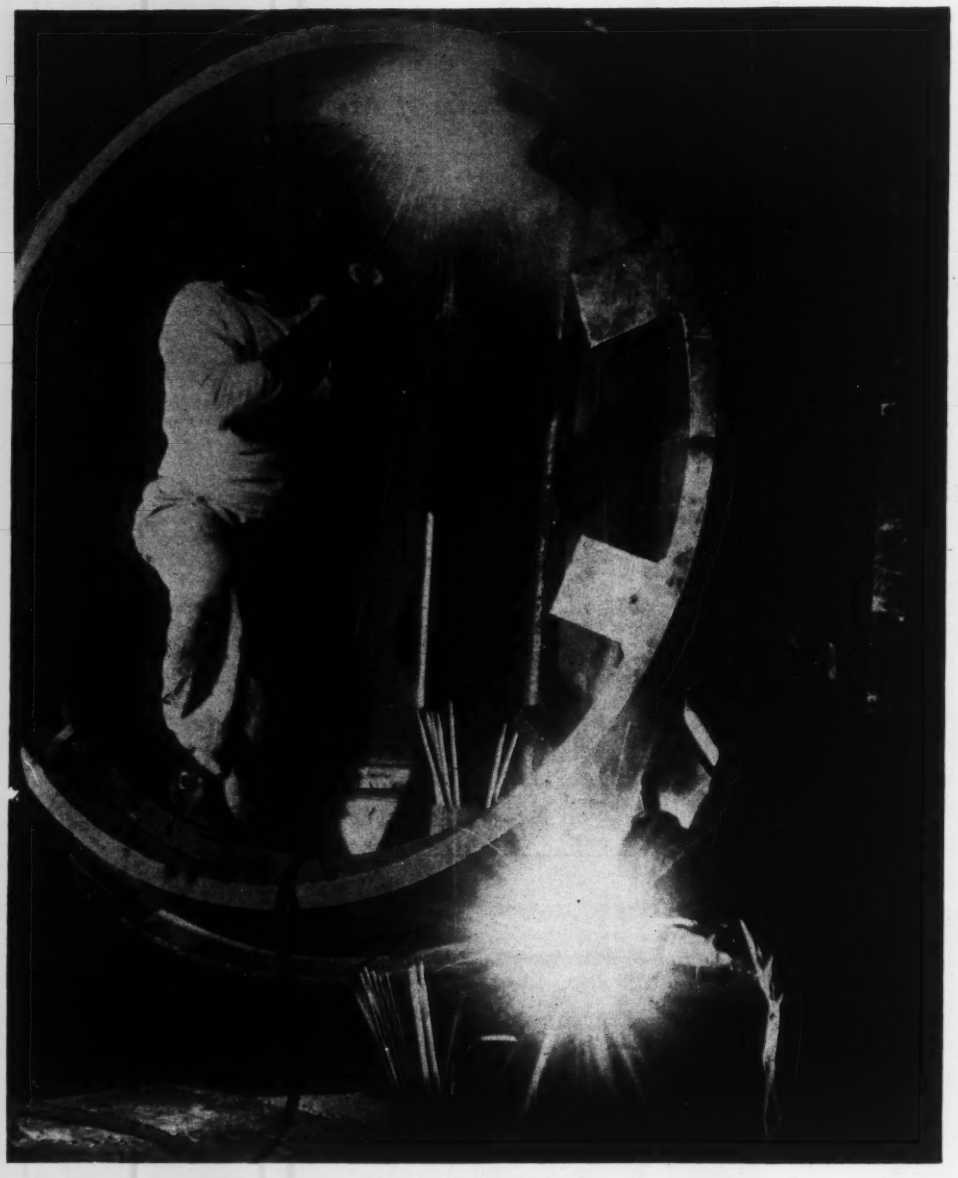

*Welding a Tank Turret*

*(Preparing tank turret to fit into the hull of the redesigned M-47 General Patton army tank at the Eddystone, Pa., plant of Baldwin-Lima-Hamilton Corporation)*

VOLUME 73
No. 9

# MECHANICAL ENGINEERING

SEPTEMBER
1951

GEORGE A. STETSON, *Editor*

## *Four Great Teachers*

IN recent months engineering education has lost four great teachers and The American Society of Mechanical Engineers four distinguished members—Charles E. Ferris, Edward L. Moreland, Dugald C. Jackson, and Boris A. Bakhmeteff.

Dean Ferris, Honorary Member ASME, who died on May 19, 1951, in his eighty-seventh year, a native of Ohio and graduate of Michigan State College, began his teaching career at the University of Tennessee in 1892. He later became professor of mechanical engineering and, in 1910, the first dean of engineering at the University, a post held until retirement in 1940.

The warmth of his personality won for Dean Ferris the respect and affection of colleagues and students alike. His accurate appraisal of men made him an able administrator in choosing colleagues and handling students. He could detect students who would succeed in engineering and he saved from disappointment men not suited to advance in the profession. This valuable faculty was put to use even after his retirement when he assisted in recruiting men for the Manhattan Project. A keen sense of humor and an uncanny ability to anticipate mischief always kept him one jump ahead of the undergraduates. And when he foiled their schemes and unmasked the ringleaders he did so in a manner which won for him their affection and friendship. His hobby was making furniture and revitalizing memories of happy days with "old grads" who dropped in on him to recapture the spark of inspiration that had brightened their undergraduate days and influenced their careers.

The deaths of Dugald C. Jackson and Edward C. Moreland occurred only two weeks apart and only a few weeks before the anniversary of the engineering firm which bears their names.

Dugald C. Jackson, Honorary Member ASME, who died on July 1, 1951, epitomized the development of electrical-engineering education and practice since his graduation from Pennsylvania State College in 1885. He belonged to an era in which young but bold and talented men pioneered in a new field of engineering, one not based on the traditional mechanic arts but upon the science of electricity. In his early twenties he was in responsible charge of electrical manufacturing work. In 1891, with his brother, W. B. Jackson, he organized a firm of consulting engineers and also began, at the University of Wisconsin, his career as a teacher of electrical engineering. He became head of the department of electrical engineering at M.I.T. in 1907, a position he held until 1935, and organized in 1919 the consulting firm of Jackson and Moreland, in which he was senior partner until 1930.

During a long and useful life Dr. Jackson received many honors, gave freely of himself to engineering and educational societies, wrote extensively, served with distinction as a consulting engineer, and exerted a lasting impression on generations of engineering graduates. Until prevented by failing health, he was prominent in the affairs of the Engineers' Council for Professional Development, and he made a major contribution to the advancement of his chosen profession by fostering the preparation and adoption of the ECPD Canons of Ethics.

Professor Moreland, member ASME, who died on June 17, 1951, at the age of 65, was a graduate of The Johns Hopkins University, where he majored in mathematics and physics. In 1908 he received a master's degree from M.I.T. and entered the engineering firm of D. C. and W. B. Jackson as personal assistant to Dr. Jackson. In 1919, after the first world war, in which Moreland served, the firm of Jackson and Moreland was formed. In 1935 Moreland succeeded Dr. Jackson as head of the electrical-engineering department at M.I.T. He was appointed dean of engineering in 1938, and executive vice-president in 1946, an office from which he recently retired. The experiences of consulting practice enriched Professor Moreland's effectiveness as a teacher and college administrator. His services were frequently in demand by the government. Engineers applauded his appointment as a member of the recently established National Science Foundation.

Boris A. Bakhmeteff, member ASME, honorary professor of civil engineering at Columbia University, hydraulic engineer, consultant, industrialist, statesman, died on July 21, 1951. He was born in Stalin's home town of Tiflis, in the Caucasus, May 14, 1880, and was educated in Russia and Switzerland. He came to this country in 1917 as Russian ambassador, under the Kerensky government, and only relinquished that post in 1922. He had established a reputation in Russia as a hydraulic engineer and teacher of hydraulics, was chief engineer for the Dnieper project, later developed by the Soviets, and had served his government in several important capacities.

Cut off from his native land by the Bolshevist revolution, he remained in this country, became a naturalized citizen, organized several industrial enterprises which provided employment for other refugees, and was appointed a professor of civil engineering at Columbia in 1931. He devoted much time to engineering-society service as chairman of the Science Legislation Panel of EJC, and member of the ASCE research committee and The Engineering Foundation.

# POWER INDUSTRY'S ROLE *in* ATOMIC-ENERGY DEVELOPMENT

## INTRODUCTION

THE letter from the Atomic Energy Commission which designated the three members of this group as an Ad Hoc Advisory Committee asked us "to become acquainted with the projects and technological problems of the AEC reactor program with a view to recommending a workable plan for . . . co-operation with the electric power industry which will most effectively serve the needs of the Commission" and that industry. The assignment was somewhat amplified in terms of reference which are appended to this report.[1]

The phrase "electric power industry" means the electric utilities, both publicly and privately owned, which produce or distribute electricity for public use. The utilities are concerned with nuclear reactors and in their development in somewhat the same way that they have been and still are concerned with research and development on boilers, turbines, generators, heat exchangers, and the other conventional types of power equipment, and with fuels and their processing. Generally speaking, the electric systems have not found ways to give effect to their interest in this new field because security restrictions and the requirements of government monopoly offer such formidable obstacles to traditional industrial participation.

The situation of the utilities is in contrast to that of such classes of concerns as chemical and equipment manufacturers. The impact of security requirements and Commission monopoly is minimized for these concerns because they can become AEC contractors for substantial phases of reactor development and thus be an integral part of the atomic enterprise. Examples are the power-equipment manufacturers, a group not included in the term "electric power industry." As the original AEC letter to us recognized, the electric power industry, whose primary function is not to manufacture but to utilize equipment, does not have the same opportunities to participate in the reactor program through contract operations. The Ad Hoc Committee was, therefore, set up by the Commission to help find other means to bring the utilities into active contact with the atomic energy enterprise.

In preparing this report we have avoided inclusion of any classified material. We were given access freely, however, to the secret as well as nonsecret information relevant to our study, and this opportunity has been essential to completion of our work. As suggested by the Commission, we visited most of the installations where major research and development were being carried on. We also had numerous conferences in Washington and at these sites and elsewhere with the staffs of the AEC and its contractors. We wish to express our appreciation for the generous assistance which these groups gave us at all times. In particular, we want to thank Dr. Lawrence R. Hafstad, director of the Division of Reactor Development, for his personal interest in our work; Mr. James K. Pickard, of his staff, and Mr. Willam A. W. Krebs, Jr., of the AEC Legal Staff, who accompanied us during some inspection trips and attended a number of our conferences; Dr. Robert Oppenheimer, who extended the hospitalities of the Institute for Advanced Study at Princeton for our final discussions, and Mr. Herbert S. Marks, a former General Counsel of the AEC, who advised with us during that stage.

## 1 POWER INDUSTRY'S INTEREST IN ATOMIC POWER

The special interest of the electric power industry in the Commission's enterprise derives from the prospect of utilizing atomic power for ordinary central-station purposes. If this prospect becomes a commercial reality, then—aside from weapon production—the power systems of the country could be the largest potential users of nuclear reactors just as they are today the largest users of fuel-fired steam boilers. Similarly they could become the largest potential users of nuclear fuel, just as they are today the largest single user of coal.

Whether and when atomic power becomes commercially feasible depends upon the Commission's nuclear-reactor program, a program which—except for the piles producing plutonium for bombs—is still in the research and pilot-plant stage. While none of the reactors which are part of the present AEC program have been designed primarily with an eye to industrial power production, they will, as the Commission has indicated, give "impetus to the ultimate use of nuclear energy" for such purpose. The AEC-Westinghouse land prototype for a submarine propulsion machine is well under construction at the Reactor Testing Station in Idaho; the companion project for which General Electric is contractor will soon be under construction, and we are encouraged to believe that before many years one or both will actually be operating a submarine. In another sense, the Material Testing Reactor, scheduled for operation at the Idaho site, should also greatly advance fundamental reactor technology.

We were impressed, too, by the homogeneous reactor at Oak Ridge which promises to illuminate several key problems relevant to the eventual development of a practical power reactor, and by the hopes in the possibility of nuclear breeding. If, as one member of the Commission remarked the other day, "the intriguing possibility of nuclear breeding can be made a reality . . . it may very well give us a reduction of cost of atomic power to where it can compete with our other sources." While the prospect of breeding has the most dramatic appeal, there are other possibilities with more limited implications. For example, the ideas being studied just now for combining production of plutonium for weapons with utilization of by-product heat energy, although perhaps not economical for power production generally, may be feasible for specific projects under conditions where, as now, the military need of the prime product, plutonium, gives it a special monetary value.

It is clear to us that no valid judgment can yet be made as to whether and on what scale nuclear reactors will ultimately contribute to our energy resources. Nevertheless, our own observations, reinforced by recent pronouncements of the AEC, convince us that the prospects of an important new source of power within the next decades are robust enough to warrant

[1] Omitted from this printing.—EDITOR.

Text of report of the Ad Hoc Advisory Committee on Co-Operation Between the Electric Power Industry and the Atomic Energy Commission, submitted to the Commission on March 28, 1951, and released for publication June 22, 1951. The Ad Hoc Committee was set up by the Commission on July 28, 1949, and consists of Philip Sporn, *chairman*, president, American Gas and Electric Company; E. W. Morehouse, General Public Utilities Corporation; and Walton Seymour, then of the Program Division, U. S. Department of Interior, and now adviser on power problems to the Economic Co-Operation Administration.

a strong present and continuing interest on the part of the electric power industry. This is not because conventional methods of producing power are unsatisfactory. On the contrary, Commissioner Pike accurately described the situation when he said recently that, "Because of our natural endowment of large amounts of cheap coal, oil, and natural gas, and our continuous developments and techniques of large-scale power-production units, we have set a very difficult mark for any new source of power to meet." But the same conditions which helped bring the art of conventional power production to its present stage also foster an interest in a new source of heat energy potentially capable of providing a further advance in the art.

Electric generation in the United States has been predominantly dependent upon steam, that is, upon fuel, and it will certainly continue to be heavily dependent upon heat energy. Hydro power, though substantial, can provide only a part of our rapidly growing requirements because the remaining undeveloped water-power sites are limited. The industry today requires in the operation of its steam plants fuel equivalent to about 100 million tons of coal annually—roughly one sixth of the country's coal consumption. Demands for power have been expanding and will continue to expand dynamically. Capacity has doubled on the average every decade for the past forty years, and it is reasonable to believe that this will happen again in the next ten years, and that a substantial rate of growth will continue thereafter. A variety of factors, not least of which is the close attention to improvements in technology, have enabled the electric industry to keep costs of service to the consumer on a more or less steadily declining curve, even during the past decade when other costs were rising sharply.

The industry should, therefore, be strongly attracted by any prospect for the production of heat energy which might bring about a material lowering in cost of steam power production. In saying this, no one should expect that commercially feasible atomic power would mean radical reductions in power costs. If nuclear reactors can produce heat energy for power plants, that energy would replace the fuel element in conventional electric generation but with some increase in capital costs. There is little if any prospect that the over-all cost reduction could be revolutionary, but the results could be significant, especially for a number of industrial operations which any appreciable lowering of power costs would stimulate. Examples are reduction of magnesium and aluminum, refining of copper, production of cement, chlorine, and caustic soda, and like operations where electric power represents a relatively substantial part of the cost of the finished product. Significant economic consequences might also be anticipated through the development of new uses of electricity in industries where the application of power to industrial processes may now be retarded by cost factors.

Quite apart from the possibility of cost reduction through nuclear reactors, such a new source of heat energy might afford advantages in compactness relative to conventional fuels and in the extensive supplies that would become available if breeding is perfected.

The fact that the possibility of commercially feasible heat energy from nuclear reactors cannot be realized for some years or longer ought not to weaken its attraction for the electric industry. A constantly expanding market, the large capital expense required to meet the demand, the relatively long cycle for installing new facilities, and the long life of equipment have accustomed the industry to look and plan many years ahead.

The nature of the industry's interest in nuclear reactors can also be stated in terms which describe its role in the changing technology of conventional power production: In order to make wise current plans and prudent investments for the future, the industry must at all times keep abreast of developments relating to power production and what they foreshadow; in order to keep costs down and improve service, the industry must contribute as directly and as effectively as it can to promoting advances in technology.

In the field of conventional power production the industry is able to give effect to these interests through its working relationships with the manufacturers of power equipment, producers of fuel, and with the other institutions where research and development are carried on. Today, for example, a 38 per cent thermal efficiency is achieved in the best of the new power plants; a few years ago the efficiency of the best plants was only 13 to 15 per cent. The present high thermal efficiency may fairly be credited to the joint efforts of the manufacturers and the electric systems who constantly collaborated with one another in improving the art. The accumulated operating experience of the electric systems and their special knowledge of their own requirements and those of their customers have been combined through the years with the special knowledge and facilities of the manufacturers to produce from year to year new and better types of equipment.

A major contributing factor in the process just described has been the practice of the members of the electric power industry, in contrast to most other industries, to share their technical and operating experience fully and freely with one another. This practice has tended to quicken the pace of technological development.

Perhaps most important from the standpoint of the utilities, their collaboration with the manufacturers and with one another has enabled them to become informed of latest developments as they occur. It is only as a part of this process that they are able to evaluate reliably the prospects for still other improvements in the future. All this knowledge in turn becomes a key to the planning which the electric systems do in order to meet the constantly expanding demand for power, to promote new and better uses of power, and to keep costs down.

What we have just described is the traditional participation of the electric systems in the technological process of developing conventional power equipment. This process, which has been beneficial to the electric utilities, to other power producers, and to the manufacturers of equipment, has for its ultimate beneficiary the public at large.

We take it to be an objective of our industry and the Commission to create conditions governing the electric power industry's relation to nuclear development which will be as nearly like these normal conditions as may be consistent with the requirements of security.

## II AREAS OF MUTUAL INTEREST TO POWER INDUSTRY AND AEC

To describe the electric industry's concern with atomic energy is to see only one side of the picture. There is also a pervasive community of interest between the Atomic Energy Commission and this industry, essentially because the electric systems are likely to be the principal medium for distributing to the public whatever benefits are to flow from nuclear fuel. In order to turn this mutuality into a constructive working relationship, our terms of reference contemplated that we should "study the Commission's reactor program with a view to identifying areas or potential areas of mutual interest." It seemed reasonable to expect that as these areas were discerned and described, the elements of a program of contacts advantageous to both the industry and the AEC would suggest themselves.

During our survey of the Commission's reactor projects we noticed striking analogs to a variety of the problems which the electric industry and the manufacturers had encountered as

the art of conventional power production advanced. These common elements included such items as the design of pressure vessels, of coolant systems (and control of purity of coolants), of pumps, piping, and heat-transfer systems; the electrical, mechanical, and civil-engineering aspects of reactor-plant construction; fuel preparation and ash handling; control and instrumentation; and the general relationship between reactor operating characteristics and those of conventional electric power plants.

In the collaboration between electric-industry technicians and the manufacturers of power equipment, the operating experience of the former has frequently been drawn upon in solving problems of this type. Our discussions with the personnel associated with the reactor projects suggested that a similar joint approach to these Commission problems would be welcome and useful. The extent of the industry effort that would be required for this purpose is indicated by our estimate that during the next several years the reactor program could profitably utilize the temporary services of about twenty-five technicians per year from the electric systems of the country. The form which this collaboration might take, the precise method of pin-pointing the trouble spots to work on, and the method of selecting the individuals to do the work, are discussed later.

There is, however, a broader and more important area of mutual interest than these specific technical problems. As the Commission's reactor program proceeds, it will become increasingly necessary to make realistic appraisals of the potentialities of reactor projects as parts of electric power systems. The more closely the Commission approaches its goal of a successful power reactor, the more compelling will be the need for these over-all engineering-economic judgments. In the meantime, the soundness with which selections are made among a variety of alternative paths to the ultimate end will depend upon how well judgments of the same general kind are made.

These analyses will require not only the talents of the physicists, chemists, chemical and mechanical engineers who are engaged in the Commission's reactor program. They will also require talents which now reside in the system planning engineer, power-supply engineer, transmission engineer, and in the utility management experts, who have responsibility for utility economics in the electric power industry.

The application of the body of knowledge and experience called utility economics is a major function of the industry's management and engineering personnel in the decisions which have to be made constantly in maintaining and expanding power networks. The issues which are dealt with in this field involve the balancing of all the many factors entering into final cost in an operation in which a great many variables can be introduced, to give an over-all most economical result. Not only are choice and determination of emphasis made between capital, or fixed, and operating, or variable costs, but the effects of different rates of depreciation of the various schemes are evaluated. And there is always present the question of how far to go in extra expenditure on projects being created today to avoid heavy losses or heavy expenditures on expansion of those projects ten or fifteen years from today; these questions alone are most difficult, but their consideration invariably raises a host of subsidiary questions of great difficulty and complexity—well illustrated by some of the problems which confronted the utilities who recently submitted proposals to supply the Commission's Paducah Project.

There is a need to bring similar techniques of analysis and judgment to bear on aspects of the AEC reactor program. In pursuing the idea of a nuclear reactor for the production of plutonium and by-product heat energy for power, this type of appraisal is pointedly relevant. The problem will become increasingly complex and pressing as the time approaches when a nuclear reactor is designed primarily for the production of heat energy for a power plant. The Commission then will require more and more refined analyses of such important items as: Capital costs of reactors and their complementary parts to give total investment costs in a complete system of electric power generation; dependability of reactors, that is, the proportion of the time that the reactors would be reliably available for power supply at full capability; costs of reactor maintenance; costs in starting and stopping units; costs of feed material and handling of feed material, including prospects as to cost and availability of such fuel covering at least the period of the economic life of the initial investment; the problems of integration of nuclear power into existing power networks; and finally the over-all cost, both capital and operating, of the power obtained from such nuclear reactors and the relative advantages or disadvantages of such power as compared with that from other competing sources for which, if economical, it would be substituted.

Both the Commission and the electric industry have a stake in assuring a sound approach to these problems. Reliable, illuminating-system analyses will enable the Commission to maintain a more direct course toward its ultimate goal; and for the industry, the more competently these problems are dealt with, the more effectively the electric systems will be able to integrate power reactors, if and when they are feasible, into the highly organized system of electric supply which characterizes this country's economy.

This area of mutual interest—that is, the domain of utility economics—impresses us as the most important in which to establish contacts between the Commission and the industry. It is also the most difficult because of the time required to create effective working relations between groups within the AEC enterprise and the industry and to build up the joint body of knowledge and experience which is the prerequisite to useful appraisals and judgment. The program of continuing co-operation which the AEC asked us to help devise should have as one of its main objectives the formation of such working relations and the building up of such knowledge and experience.

### III A PROGRAM OF CONTINUING CO-OPERATION

The AEC Industrial Advisory Group's report of two years ago[2] "placed primary emphasis upon increasing industry's knowledge about atomic energy." It was the strong view of that Group that "as industry acquires a larger share of organized, detailed information . . . industry and the Commission, working together, will find many ways of increasing industry's part in the enterprise." It would appear that events are beginning to bear out this theory.

An example is the recently approved project for reactor feasibility studies by The Detroit Edison and the Dow Chemical companies, and by the Monsanto Chemical Company. The Commission remarked in approving them that "these proposals appear to offer not only an opportunity for bringing new technical and management resources into the atomic-energy program; they also are oriented toward important Atomic Energy Commission objectives—the production of plutonium and other important materials, together with power, in a reactor; and they may ultimately lead to arrangements where, because initiative is with industry, additional incentives for rapid and aggressive technical and business development will exist."

For our purposes it is an equally important point that the industrialists who sponsored these proposals were men who had previously had absorbing contacts with atomic energy.

[2] See MECHANICAL ENGINEERING, March, 1949, pp. 205–212.—EDITOR.

Their connection with the enterprise began long before they presented their ideas to the AEC; without such contacts their proposals could scarcely have been conceived.

In order that the power industry may attain a part in atomic energy at all comparable to the useful role it has had in the development of conventional power equipment, it must first become educated about the subject. One opportunity along this line which it is up to the industry to take advantage of, is the Commission's Oak Ridge School of Reactor Technology which has just announced its 1951–1952 session. Here, as the most recent AEC release points out, qualified trainees from industrial firms can secure a substantial background in reactor technology and allied subjects. We would hope and expect as time goes on that personnel from the electric industry would seek admission to sessions of this school, and that the school would emphasize those features of training which would make it worth while for such personnel to attend.

Another valuable type of educational experience is that to be secured by power-industry technicians as a by-product of assignments to assist the Commission with the specific technological problems referred to in the preceding section. It was our estimate that during the next several years approximately twenty-five such technicians per year could be used effectively on a temporary basis by the Commission on problems of coolants, heat-transfer systems, etc., where electric-industry experience seems peculiarly relevant.

As they return to their own companies, the men assigned to these specific technical jobs (as well as those who attend the Oak Ridge School) would form a reservoir of informed personnel. The mere existence of such a group would in numerous ways enhance the opportunities for other constructive contacts with the atomic-energy enterprise and the capacity of the industry to evaluate developments.

The mechanics of finding power-industry people for these temporary Commission assignments brings us to the question of a permanent industry committee, a matter about which the Ad Hoc Committee's terms of reference requested our opinion. We believe that a permanent committee should be set up and suggest that its first assignment should be to provide organized power-industry assistance to the various Commission projects in identifying the places where industry personnel could be helpful, and to locate the personnel within the industry who might be detailed to fullfill these needs.

At least in the beginning, the Committee's role should be conceived in quite simple terms. Like the Industrial Advisory Group, we can see the usefulness of the industry committee device. But we agree also with the view of that group that it is easy to exaggerate the direct assistance that such special committees can give the Commission. They can be valuable "provided they are reviewed in perspective as but one modest feature in solving the immensely large and difficult problem of industrial participation in atomic energy." Certainly, initially, as the Industrial Advisory Group put it, "a principal value of the advisory committee idea lies in the education of industry."

Bearing these qualifications in mind, we recommend an industry committee that would be broadly representative of the electric power industry. Membership of ten to fifteen individuals would accomplish such representation, while keeping the size within manageable limits. The members should be drawn from the top executive ranks of the electric systems; at least a substantial portion of them should have some engineering background; and staggered terms of membership are desirable so that over a period of years a larger number of industry executives could have the experience of membership. All members of the Committee should be cleared. Presumably they would meet according to some more or less regular schedule and would have the assistance of minimum staff facilities. If the Commission wishes, we are prepared to discuss the details concerned with the setting up of this permanent group.[3]

The Committee members should be given an opportunity to familiarize themselves with the reactor program and other relevant phases of the Commission's enterprise. In the first instance, a visit to Commission installations similar to that afforded the Ad Hoc Committee would be informative and educational to them as it was to us. We believe that this could be arranged in such a way that it would not cause serious inconvenience to the Commission's staff.

After the Committee gains some experience with the enterprise and after it has assumed its first task of bringing power-industry technicians into the specific parts of the Commission's work where such assistance is needed, it should then take on a second assignment. This should be essentially a responsibility to make reports to the power industry to keep it abreast of developments in the atomic-energy field and of their implications. These reports would have to conform to security requirements, and it would be necessary that they be carefully reviewed for accuracy of statement and interpretation But it is clear to us that such nonclassified reports supplementing the general reports which the Commission now publishes could be of considerable value to the industry. The Commission's present reports are geared to the public at large or to the Congress. The information which the power industry most needs would be of a sufficiently different character to warrant considerable effort on the part of an industry committee to formulate and present them. Some of the reports could be written, but oral reports at industry meetings which the Committee might arrange are also desirable. In the course of developing these reports, we believe that another aim of the Commission, also stated in our terms of reference, would be furthered, namely, the identification of additional declassifiable information regarding reactor development which might be useful to the industry as a whole.

As contacts develop along the lines described in this section, further measures of mutual value will suggest themselves. Additional proposals like the current Detroit Edison reactor feasibility study should certainly be welcomed to the extent that the conduct of such studies does not infringe on other pressing AEC work. We would expect other proposals along these lines to emerge as the numerous segments of the industry build up closer relations with the enterprise. The permanent industry committee should not only play an important part in catalyzing and helping shape such projects but may possibly become the instrumentality for setting up one or more projects participated in by the power industry as a whole.

Such projects moreover, whether sponsored by individual systems or under committee auspices, represent probably the most practical initial approach to the problem of over-all economic-engineering appraisal of reactor development and its place in relation to the general problem of power supply. As we have said, this, the domain of utility economics, impresses us as the most important area of mutual interest to the AEC and the industry. It is also the area with the greatest difficulties and complications. The techniques applied by industry management and industry engineers afford a method of approach to the problems in this field. The application of these techniques, which combine elements of art with those of science, should however not be attempted along the lines of any preconceived plan but should be permitted to evolve as the Com-

*(Continued on page 708)*

[3] In a letter of June 20, 1951, to Philip Sporn, Gordon Dean, chairman, U. S. Atomic Energy Commission, wrote: "In connection with your recommendation for the establishment of a permanent advisory committee, we would like to have your suggestions as to terms of reference and organization."—EDITOR.

# WATER POLLUTION *by* INDUSTRY

## *A Survey of State Legislation and Regulations*

By D. F. OTHMER,[1] M. D. WEISS,[2] AND R. S. ARIES[3]

THE regulation of industrial pollution has received increased attention during the last decade. At least 29 states have adopted new legislation, revised existing legislation, or modified associated regulations since the publication of the last legislative survey.[4] These changes, often in basic policy, are of tremendous import to the industries located within the borders of the state. The cost of waste treatment, a function of the nature of the waste, is also dependent upon the requirements of the state with respect to waste-treatment effluents.

An extensive report of the findings of a survey of state legislation and regulations has been published.[5] This paper is a summary of the broader findings of that survey which includes data from all the states and territories of the United States with the exception of Wyoming and Colorado.

### FEDERAL WATER-POLLUTION-CONTROL LEGISLATION

Although the Federal Government has had some form of pollution-control legislation since 1899,[6] as part of river and harbor legislation, it was not until the adoption of the Water Pollution Control Act of 1948,[7] that a separate program was established for this purpose. The new legislation put into words the policy of co-operation that had been practiced by the previous enforcement agency, and it furnished funds for aid to interstate, state, and municipal agencies in the formulation and execution of their pollution-control programs.

The Water Pollution Control Division of the Public Health Service has been established to carry out the provisions of the 1948 Act. One of its many activities has been to strive toward the attainment of uniform water-pollution legislation among the states. An outline of such legislation is discussed in detail in the previously mentioned survey.[5] The outline has resulted in a more uniform approach to pollution-control legislation despite the major differences in the actual pollution problems in the states.

### WHAT IS POLLUTION?

Although the tendency of state legislation is toward uniformity, the states differ markedly in their definitions of pollution. The State of Illinois, for example, defines pollution[8] as the impairment to waters of the state that might result from the discharge of any liquid or solid substance. The State of Indiana[9] does not define pollution per se but allows its Stream Control Board to determine when a stream is polluted.

In a classic definitive regulation the Stream Control Board of Indiana describes the considerations it recognizes in establishing whether a stream is polluted. The five basic considerations of the board are as follows:

1 The character of all surface water is affected by the mode of life of the people and the activities of industry. Both the people and industry are dependent upon the surface water to some extent.

2 Concentrations of population may exist on streams with low flow. Diluting water will then be insufficient to maintain suitable oxygen concentrations even though reasonable methods of waste treatment are employed.

3 There is a fair economic balance between cost of treatment of waste and benefits received, beyond which it is not reasonable to expend money for treatment.

4 The natural purifying agencies of the stream should be utilized.

5 The necessary degree of purity of surface waters depends upon the subsequent use which will be made of these waters.

In brief, the biochemical characteristics of a waterway resulting from the discharge of wastes is not the only factor which determines whether a waterway is polluted. Concentrations of population, volume of flow, economic balance between costs and benefits, the natural purification characteristics of the stream, and the subsequent use to be made of the waters, all determine whether a stream is to be declared polluted. Details of the characteristics which are used as a measure of the polluted state of waterways will be given later.

The State of California distinguishes between pollution and contamination.[10] The impairment of state waters to the hazard of public health is called contamination. Impairment of the waters by sewage or industrial waste which does not constitute an actual public-health hazard is called pollution. Different agencies of the state enforce laws relating to these different categories. Contamination is within the province of state and local health officers. Pollution cases are handled by the State and Regional Pollution Control Boards.

### PUBLIC POLICY OF THE STATES

After formulating its definition of pollution, each state presents its public policy governing pollution control. The policy usually is a three-pronged attack[11] upon pollution problems:

1 Preventing pollution of unpolluted waters.

2 Preventing additional pollution of slightly polluted waters.

3 Abating the pollution of overpolluted waters.

Enforcement of this public policy may be vested in the hands of a Water Pollution Control Commission, of the State Department of Health, or of the State Fish and Game Commission. Old-fashioned laws divide the jurisdiction, sometimes

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[3] President, R. S. Aries and Associates, Consulting Engineers, New York, N. Y. Mem. ASME.

[4] "Pollution Abatement," by Anthony Anable and R. P. Kite, *Chemical Engineering Progress*, vol. 44, 1948, pp. 3–16.

[5] "Industrial Water Pollution—Survey of Legislation and Regulations," by M. D. Weiss, Chemonomics, Inc., New York, N. Y., 1951.

[6] Section 13, River and Harbor Act of March 3, 1899.

[7] Public Law 845, 80th Congress, June 30, 1948.

[8] Reference 5, p. 35.

[9] Ibid., p. 37.

Contributed by the Process Industries Division and presented at the Process Industries Conference, Baltimore, Md., April 17–19, 1951, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[10] Reference 5, p. 12.

[11] Ibid., p. 50.

TABLE 1 MEMBERSHIP OF WATER POLLUTION CONTROL COMMISSIONS

| State | State officials | Type of organization represented: Municipal government | County government | Fish and wildlife | Agriculture, livestock | Engineering schools | Industries | Labor | Not designated | Other |
|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | 4 | 1 | 1 | 1 | .. | 2 | 6 | .. | .. | .. |
| Alaska | All | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Arkansas | 4 | 1 | .. | .. | 1 | .. | 1 | .. | .. | .. |
| California: | | | | | | | | | | |
| State | 4 | x | x | .. | x | .. | x | .. | .. | x |
| Regional | .. | 1 | 1 | .. | 1 | .. | 1 | .. | .. | 1 |
| Connecticut | .. | .. | .. | .. | .. | .. | .. | .. | 3 | .. |
| Delaware | 7 | .. | .. | .. | .. | .. | 3 | .. | .. | .. |
| Illinois | 4 | .. | .. | .. | .. | .. | 1 | .. | .. | .. |
| Indiana | 3 | .. | .. | .. | .. | .. | .. | .. | 3 | .. |
| Kentucky | 4 | 1 | .. | .. | .. | .. | 1 | .. | .. | .. |
| Louisiana | 5 | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Maine | 4 | 2 | .. | .. | .. | .. | 2 | .. | .. | .. |
| Maryland | 4 | .. | .. | .. | .. | .. | .. | .. | 3 | .. |
| Michigan | 4 | 1 | .. | 1 | .. | .. | 1 | .. | .. | .. |
| Minnesota | 4 | .. | .. | .. | .. | .. | .. | .. | 1 | .. |
| New Hampshire | 7 | .. | .. | .. | .. | .. | 2 | .. | .. | 1 |
| New York | 5 | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Oregon | 3 | .. | .. | .. | .. | .. | .. | .. | 3 | .. |
| Pennsylvania | All | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Puerto Rico | 6 | .. | .. | .. | .. | 1 | .. | .. | .. | .. |
| So. Carolina | 3 | 1 | .. | 1 | 1 | .. | 2 | 2 | .. | .. |
| So. Dakota | All | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Tennessee | 3 | 2 | .. | .. | .. | .. | 2 | .. | .. | .. |
| Vermont | .. | .. | .. | .. | .. | .. | .. | .. | 3 | .. |
| Virginia | .. | .. | .. | .. | .. | .. | .. | .. | 5 | .. |
| Washington | 5 | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| West Virginia | 2 | .. | .. | .. | .. | .. | .. | .. | 3 | .. |
| Wisconsin | 5 | .. | .. | .. | .. | .. | .. | .. | .. | .. |

TABLE 2 SPECIFICATIONS FOR THE CLASSIFICATION OF WEST VIRGINIA STREAMS

| Determination | Period | Class AA | Class A | Class B | Class C |
|---|---|---|---|---|---|
| Coliform bacteria per 100 ml | M | Not over 100 | Not over 1000 | Not over 10000 | Over 10000 |
| Dissolved oxygen, ppm | M | Not less than 7.5 | Not less than 6.0 | Not less than 4.0 | Less than 3.0 |
| | Min D | Not less than 6.5 | Not less than 5.0 | Not less than 3.0 | Less than 2.0 |
| 5-day BOD, ppm | M | Not over 0.75 | Not over 2.5 | Not over 6.0 | Over 6.0 |
| | Max D | Not over 1.0 | Not over 3.5 | Not over 7.0 | Over 10 |
| pH | M | 6.3 to 7.7 | 5.8 to 9.0 | 3.8 to 5.8 or 9.0 to 10.5 | Less than 3.8 or over 10.5 |
| Fluorides, ppm | Max | Not over 0.5 | Not over 1.0 | Not over 1.0 | Over 1.0 |
| Chlorides, ppm | Max D | Not over 100 | Not over 250 | Not over 500 | Over 500 |
| Phenolic cpds, ppb | Max | None | Not over 5.0 | Not over 25 | Over 25 |
| Iron, ppm | Max | Not over 0.3 | Not over 0.3 | ..... | ..... |
| Color | Max | Not over 20 | Not over 100 | ..... | ..... |
| Turbidity, ppm | Max | Not over 10[a] | Not over 250[a] | ..... | ..... |
| Sludge deposits | .... | None | None | Slight to moderate | Moderate to heavy |

[a] Except as the result of a heavy rain.
NOTES: Period: M = average any month; Min D = minimum any day; Max D = maximum any day.

between all three agencies. Modern laws establish centralized control under the Water Pollution Control Commission.

*Water Pollution Control Commissions.* The Water Pollution Control Commissions established under recent laws consist of representatives of state government, municipal government, county government, fish and wildlife interests, agriculture and livestock interests, educational institutions, industry and labor. No one commission has representatives of all of these interests, but of the 27 states that have Water Pollution Control Commissions, 11 have designated specifically that representatives of industry must be appointed. The character of the 27 commissions is indicated in Table 1.

In most states the Water Pollution Control Commission is a policy-making board which promulgates rules and regulations to be enforced by employees of the State Health Departments. In some states boards enforce regulations directly.

*Standards of Treatment and Quality.* In enforcing their public policy, the state, or its designated policy-making group, often establishes standards to be met by the dischargers of wastes within the state. Standards are approached from two angles: standards of treatment, and standards of water quality.

The State of Pennsylvania is the leading advocate of the former.[12] Regulations have been adopted by the Sanitary Water Board governing the wastes from five industries; milk, oil and natural-gas wells, wells other than oil and natural gas, acid pickling wastes, pulp and paper wastes.

The board designates whether the type of treatment required on a given waterway is to be primary, intermediate, or complete, and the regulations specify the standard of treatment required for each waste to meet the designation of the board.

### STANDARDS OF WATER QUALITY

In establishing standards of water-quality criteria, the states subdivide and classify their waterways according to usage, and then specify the characteristics that must be maintained in each waterway in order to meet the requirements of that usage.

The waters of the State of New Hampshire, for example, have been divided into the following classes:[13]

[12] Reference 5, pp. 100–106.
[13] Ibid., p. 75.

TABLE 3 TENTATIVE STANDARDS—NEW ENGLAND INTERSTATE COMMISSION

| Determination | Class A | Class B | Class C | Class D |
|---|---|---|---|---|
| Minimum dissolved oxygen | 75 per cent sat | 75 per cent sat | 5 ppm | Present at all times |
| Oil and grease | None | Not appreciable | Not objectionable | Not objectionable |
| Odor, scum, floating solids or debris | None | None | None | Not objectionable |
| Sludge deposits | None | None | None | Not objectionable |
| Color and turbidity | None | Not objectionable | Not objectionable | Not objectionable |
| Phenols | None | None | None | ..... |
| Toxic substances | None | None | Not in toxic conc. | Not in toxic conc. |
| Free acids or alkalies | None | None | None | Not objectionable |
| Coliform bacteria | Within limits set by State Dept of Health | | | |

NOTE: Waters falling below these standards are considered unsatisfactory and in Class E.

Class A: Water fit for public water supply and bathing.

Class B: Subdivided into two parts—

B1: Fit for bathing and for water supply with treatment.

B2: Acceptable for boating and fishing, for industrial purposes, and for use as water supply with adequate treatment.

Class C: Acceptable for boating, fishing, and industrial water supply, with or without treatment, depending upon individual requirements.

Class D: Water devoted to transportation of industrial wastes and sewage.

In the State of New York[14] the tentative classification subdivides each one of the following waters according to usage: fresh surface waters, tidal salt waters, underground waters. Standards are set for each subdivision for such factors as solids content, odor-producing substances, pH, dissolved oxygen, and toxic wastes. Similar detailed standards are under consideration in the State of California,[15] without lettering each classification but by a simple designation of the best usage of the waterway.

An idea of the type of requirement made by states in specifying water-quality criteria may be obtained from the Standards of the State of West Virginia,[16] as presented in Table 2.

The policy of the State of West Virginia is to establish zones of pollution based on the specifications outlined in Table 2. Every mile of every major stream in the state is to be classified from these specifications, utilizing the four water-quality zones as follows:

Class AA: Excellent source of water supply, fish habitat, and recreational water.

Class A: Good source of water supply, fish habitat, and recreational water.

Class B: Source of water supply only with auxiliary treatment; poor fish habitat and recreational water.

Class C: Unsatisfactory source of water supply, fish habitat, and recreational water.

After classification, the stream is divided into "Zones of Pollution" which are mapped and published in a "Zoning Report." Included in the report is a list of first, second, and third priority industries and municipalities which are required to provide treatment facilities. Industries in Class C zones, or in first priority are sent a notice to provide treatment facilities with their copy of the "Zoning Report." Assistance of the Water Commission and of the Department of Health is made available in the preparation of a waste treatment program.

### INTERSTATE AGENCIES

Interstate agencies have grown up along four major river basins in the East. The basins and waterways concerned include the Potomac River Basin, the Delaware River Basin, New York Harbor and vicinity, and the New England waterways. The Ohio River Valley Commission is active along the Ohio River Basin.

[14] Reference 5, pp. 80–86.
[15] Ibid., pp. 12–21.
[16] Ibid., pp. 129.

Marine fisheries commissions have been organized to protect the interests of the fishing industries. Three such organizations have been formed, one along the Atlantic seaboard, one along the Gulf Coast, and one along the Pacific Coast. The states involved have official representation on these commissions, and these organizations have been recognized by the Federal Government as interstate water-pollution-control agencies.

Standards for water classification have been established by the New England, Delaware River, and Potomac River agencies. These standards are similar to those presented in Table 2 for West Virginia (a member of the Potomac River Basin organization). As another example of these standards, Table 3 is presented comprising the Tentative Standards of the New England Interstate Commission. It will be noted that the standards of the interstate agencies are less specific than those of the single states. This lack of specificity allows the individual states some latitude in setting the standards for its own streams.

### SUMMARY

In summary, it may be said that the states are showing an increasingly realistic approach to pollution-control programs, that industry is showing an increased desire to co-operate with the states in solving pollution-control problems, that the Federal Government is taking an increasing part in controlling pollution by advising local agencies, and that the pollution-control program is proceeding on a more uniform and purposeful basis than during previous decades.

## Power Industry's Role in Atomic Energy Development

(*Continued from page 705*)

mission, the Committee members, and the industry acquire a common body of experience.

* * * *

The Atomic Energy Commission is now laboring with a program of immense size, variety, and difficulty. No one should expect—least of all the members of this group—that a body like ours could devise a plan of co-operation which would promise large, immediate advantages to the AEC's vast program or for that matter to the industry. There is, however, as we have sought to show, an important community of interest between the industry and the enterprise, and the cumulative effects of action with respect to the points of collaboration suggested in this report could be significant. We think it much less important to attempt to anticipate and describe just now the precise benefits which the atomic-energy enterprise and the industry should expect from such a program of co-operation than it is to lay the groundwork from which some of these benefits may later spring.

# NATURAL STEAM POWER PLANTS OF LARDERELLO

## *Report on the Industrial Exploitation of Natural Steam in Italy*

By GIUSEPPE DONATO

RESIDENT REPRESENTATIVE, E. MARELLI & COMPANY, c/o FOREIGN ENGINEERING DEPARTMENT, WESTINGHOUSE ELECTRIC CORPORATION EAST PITTSBURGH, PA.

AS long as 2000 years ago the phenomenon of Italian boric fumaroles interested man—not only for its strangeness but also its scientific importance and, at the close of the nineteenth century, for its possible industrial uses.

These pseudovolcanic manifestations are located in a 77-square-mile region with its center in Larderello, near Florence, Italy. The white mobile natural steam and various gases exit from the ground with great violence and noise.

Physically, the fumaroles are similar to the geysers of Iceland, New Zealand, the United States (Yellowstone National Park), and the Azores, but they differ in that the geysers emit steam and hot water alternately, while the fumaroles give off natural steam almost exclusively and continuously. Temperatures and pressures vary from one fumarole to another between 290 and 400 F and 71 and 390 psi. The steam exits at between 400 and 1300 fps.

The average composition of 1000 lb of natural steam by weight is as follows: Natural steam ($H_2O$), 955.29 lb; carbon dioxide ($CO_2$), 41.85 lb; combustible gases ($CH_4$, $H_2$), 1.10 lb; hydrogen sulphide ($H_2S$), 0.92 lb; nitrogen ($N_2$), 0.30 lb; boric acid ($H_3BO_3$), 0.35 lb; ammonia ($NH_3$), 0.19 lb; rare gases (He, Ar, Ne), 27.85 cu in.

After condensation of 1000 lb of natural steam, there still remains a volume of noncondensed gas of from 2400 to 3600 gal at 0 C and 760 mm of mercury.

The condensed water contains from 0.30 to 0.40 per cent of boric acid, and 0.10 to 0.30 per cent of ammonia (by weight).

The residual gas has the following composition: Carbon dioxide, 92 to 95 per cent (by volume); hydrogen sulphide, 2 to 2.5 per cent (by volume); and other gases, $H_2$, $CH_4$, $N_2$, make up the remainder.

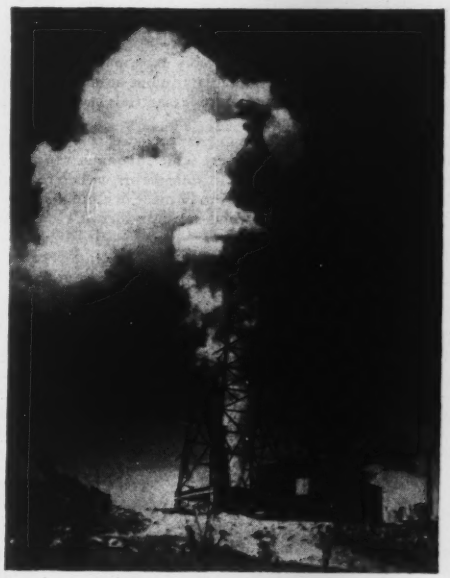

FIG. 1 FUMAROLE "CASANOVA" EXPLODED ON APRIL 20, 1948

### WELL DRILLING

The task of drilling for the natural steam is very difficult—much more so than for the usual drilling of oil wells. For example, besides the high temperatures and steam pressures, chemically active agents are ever-present. These chemicals often produce a compound which causes working drills to lock or join. In addition, the ground is stratified alternately, first soft, then hard, and generally inclined, causing heavy stresses and deflections on the drills.

The following average composition of the earth is encountered during drilling operations: (*a*) Limestones, sandstones, argils, and argil schists of the Eocene period; (*b*) jaspers quartzites of the Liassic period (early Jurassic); (*c*) limestones and anhydrites of the Retic period; and (*d*) schists and quartzites of the Permian period.

Up to the present, most of the wells ranged from 1000 to 2000 ft in depth. However, it has been noted that there is not always a relation between the depth of well and the quantity and properties of the steam, since it all depends on locating a crack which is connected, in the shortest way, with the main source of the steam. Therefore some very deep wells do not produce the same steam quantity as other wells of lesser depth in the same region.

Now, rotary-type and percussion-type drilling machines make it possible to reach depths of about 10,000 ft with a 20 to 27-in-diam hole. Wells were drilled with such equipment giving very good results. The Great Fumarole No. 1, for example, emits about 500,000 lb of steam per hr at a pressure of 50 psi, and a temperature of about 400 F; and the Great Fumarole No. 2 gives about 380,000 lb per hr of steam at about 30 psi and 360 F.

Prior to World War II, more than 140 wells were drilled for a combined total of about 100,000 ft, and a total steam production of about 4,400,000 lb per hr.

Contributed by the Power Division and presented at the Spring Meeting, Atlanta Ga., April 2–5, 1951, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The foremost problem in drilling is to reach as near as possible to the main cracks where the steam is produced. Sometimes the cracks met in drilling are rather small so that the quantity of steam is not very large. But if this little crack is directly connected with the main one, the pressure is so high that when the tool reaches it, a violent explosion occurs.

To improve the drilling operations, new and modern rotary drilling machines have been ordered from the United States, for reaching cracks 6500 ft deep with an initial diameter of about 27 in. With this type of equipment the main cracks can be reached even if some explosions occur in the drilling operation.

That the drilling operations produced very good results is exemplified by the Fumarole "Casanova" (Fig. 1) which opened on April 20, 1948, and gives approximately 280,000 lb per hr of natural steam.

### THERMOELECTRIC UTILIZATION OF NATURAL STEAM

At the end of the last century many experiments were made to exploit the natural steam industrially but only the development of the steam turbine and suitable materials made exploitation practical and economical.

Some other difficulties encountered included the following: Lack of water for the condensers which required the use of chimney-type wood coolers; acid ambient air, which required all electric connections and lines to be made of aluminum; carbon dioxide present in the natural steam, which is eliminated by means of proper separators.

The natural steam is sometimes used in reaction-type noncondensing and condensing turbines (Fig. 2). At others it is passed through heat exchangers in which pure steam is produced for use in reaction-type condensing turbines (Fig. 3) and then used for evaporating the boric waters.

The first type of plant is more simple and economical and requires less erection time. The second type is more functional and has better performance and efficiency but it is more expensive. The choice is dictated, therefore, by the actual situation and by the quantity of the steam available.

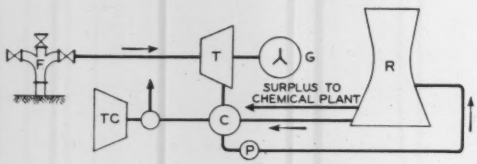


FIG. 2 DIAGRAM OF NEW NATURAL STEAM TURBINES
(C, condenser; F, fumarole; G, turbogenerator; P, pump; R, cooling tower; T, turbine; Tc, turbocompressor.)

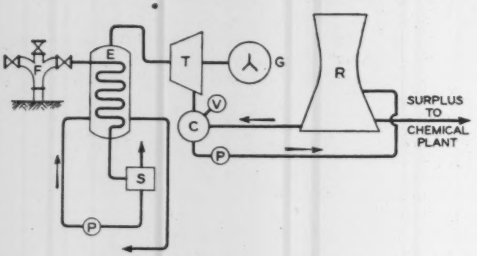


FIG. 3 DIAGRAM OF PURE STEAM TURBINES
(C, condenser; E, heat exchanger; F, fumarole; G, a-c generator; P, pump; R, cooling tower; S, condenser separator; T, turbine; V, vacuum pump.)

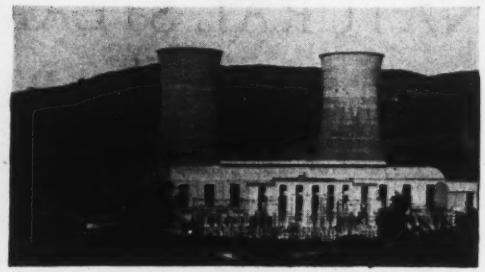

FIG. 4 VIEW OF THE CENTRAL POWER STATION NO. 3 DURING ERECTION PERIOD

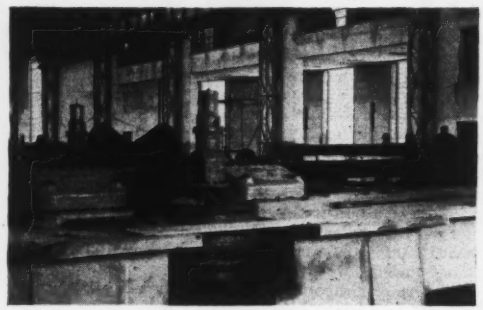

FIG. 5 ERECTION OF THE SECOND 26,000-KW UNIT FOR CENTRAL POWER STATION NO. 3

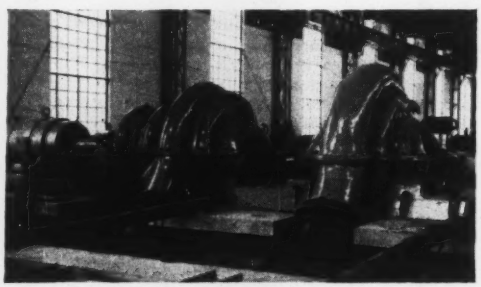

FIG. 6 ERECTION OF THE FIRST GAS COMPRESSOR FOR CENTRAL POWER STATION NO. 3

The natural steam turbines, in the old plants, were of two ratings, 3000 and 3500 kw at 3000 rpm. Both were reaction type. The steam-inlet conditions were: 64.5 psi abs and 365 F temperature, with a gas percentage, in weight, not greater than 4 per cent. The outlet conditions were 15.86 psi abs, and 220 F. These turbines had no condenser, the steam being taken directly from the turbines to the chemical plant. The turbogenerators were of the conventional type, directly connected to the turbines.

In the new Central Power Station No. 3 (Figs. 4, 5, and 6) four turbogenerator sets have been erected recently. The installation includes the following:

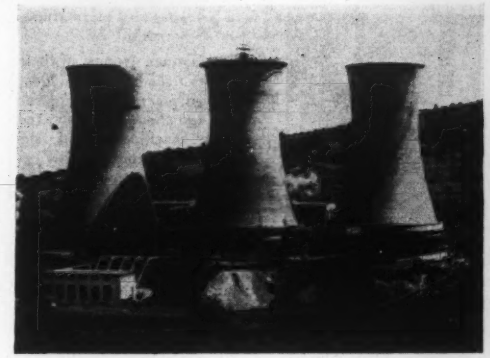

FIG. 7 CENTRAL POWER STATION NO. 2

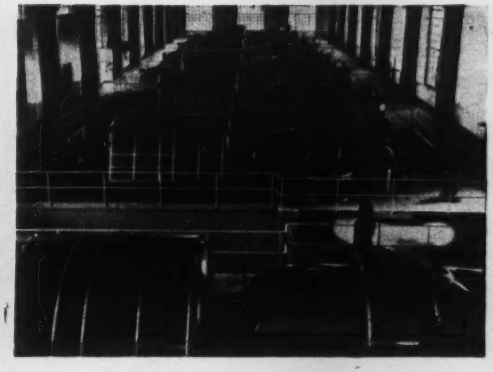

FIG. 8 INTERIOR VIEW OF CENTRAL POWER STATION NO. 2 SHOWING THE SEVEN 15,000-KVA TURBO SETS

1 Four natural steam condensing turbines (Figs. 2, 5, and 10) of rated output, 22,000 kw; maximum output, 26,000 kw; 3000 rpm; steam consumption 21 lb per kwhr; inlet steam pressure 70 psi abs; inlet steam temperature, 365 F.

2. Four condensers, able to handle natural steam with 3.9 per cent of the gases.

3 Four motor-driven turbocompressors for the extraction of the gases from the condensers (Fig. 6). The motors are rated 1000 kw at 1400 rpm, and are connected to the compressors through multiplying gears. Each compressor has a capacity of 123,000 lb per hr of $CO_2$, at 4500 rpm, with three intermediate cooling stages.

4 Four alternators (Fig. 5) of rated output, 30,000 kva; 80 per cent power factor; 10,500 volts; 50 cycles; 3000 rpm.

5 Four transformers of rated output 30,000 kva; 50 cycles; 10,500/134,000 volts.

6 Two auxiliary sets, with pure steam turbines, rated at 15,000 kva.

7 Four motor-driven horizontal centrifugal pumps for the cooling water. The motors are rated 1050 kw, 300 rpm, 4500 volts, 50 cycles, outlet pressure 69 ft of water.

Each of the four big concrete cooling towers (Fig. 4) can cool 3,300,000 gal of water per hr, from 106 to 88 F, with 77 F ambient temperature, and 60 per cent ambient humidity.

This is the newest Central Power Station of Larderello. Erection began in April, 1947, and the plant and the machines are of Italian design and manufacture.

The pure steam turbines which have been used in Central Power Station No. 2 (Figs. 7 and 8) and in the Central Power Station of Castelnuovo, are of the condensing, double-way, reaction type, with a rating of 10,000 kw, and continuous overload of 20 per cent.

At the inlet the steam has a gage pressure of 11.8 to 14.7 psi at the corresponding temperature of the saturated steam which is approximately 248 F. The steam inlet is at the center of the turbine, and the steam energy is exploited by means of two sets

FIG. 9 CONDITION OF CENTRAL POWER STATION NO. 2 AFTER THE GERMAN DESTRUCTION

FIG. 10 DRILLING EQUIPMENT AFTER THE GERMAN DESTRUCTION

of blades. At the two ends there are the two steam outlets

The cooling towers are of the hyperbolic-tower type similar to Central Power Station No. 3.

The turbogenerators are of the conventional type, 15,000 kva at 70 per cent power factor, 9000 volts, 50 cycles, 3000 rpm.

### CHEMICAL UTILIZATION OF THE NATURAL STEAM

Once the main products of the fumaroles, boric acid, borax, ammonium bicarbonate, and boron carbide, are today the by-products.

Boric acid, the most important product, is contained in the natural steam and in the waters which come from underground. It is concentrated by means of the steam itself which provides the necessary heat. The concentrated solution is then maintained hot in order to evaporate as much as possible, resulting in a further concentration and a precipitation of the boric acid during the cooling stage. The boric-acid crystals are then filtered, centrifuged, and desiccated, to obtain a product of 95–97 per cent purity. The boric acid can be further purified to 99.5 per cent.

Borax, which is second in importance, is obtained by the classical system of the reaction in solution between boric acid and sodium carbonate. Also here the borax precipitates during the cooling stage and then is pressed and desiccated.

Ammonium bicarbonate is prepared from the ammonia gas which is present in the steam that comes from the thermoelectric cycles with a concentration of 1.5 parts per thousand. This ammonia gas is condensed and rectified, obtaining a solution concentrated enough for an industrial processing. In cooled tanks the ammonia reacts with the carbon dioxide which is obtained in great quantity from the natural steam. The resulting product consists of pure ammonium bicarbonate with 21.5 per cent ammonia.

Boron carbide is a new interesting product which is obtained in an electric furnace at a high temperature by reaction of boric anhydride and special coal. It is then granulated and pulverized in commercial sizes which sometimes are only a few microns. The boron carbide has a hardness very near to that of the diamond so that it can be substituted for the latter in many applications. In addition, it is capable of being sintered.

### WAR DAMAGES AND RECONSTRUCTION

The German troops, in their retreat to the north in 1944, destroyed practically all of the power and chemical plants, the drilling machinery, and the like. Figs. 9 and 10 show examples of what was left of the Larderello plants.

Prior to the war there was an average yearly production of about 908 million kwhr, plus thousands of tons of raw boric acid and other chemical products. Following the liberation in 1944 there was no possibility of production, either of electric power or of chemical products.

During the four years following the liberation, about 18 turbogenerators were installed and made operable. Today, with the new Central Power Station No. 3, there are 21 turbogenerator sets having a total output of 254,500 kw. This nearly doubles the output of the 16 sets in operation before the war. Details are given in Table 1.

TABLE 1 CAPACITIES OF ELECTRIC GENERATING STATIONS, 1944 AND 1950

| Central Power Station | 1944 | 1950 |
|---|---|---|
| Larderello No. 1 | 2 × 3000 = 6000 kw | |
| Larderello No. 2 | 6 × 12,000 = 72,000 kw | 7 × 12,000 = 84,000 kw |
| Castelnuovo V. C. | 4 × 12,000 = 48,000 kw | 4 × 12,000 = 48,000 kw |
| | | 1 × 2000 = 2000 kw |
| Serrazzano | 2 × 3000 = 6000 kw | 2 × 3000 = 6000 kw |
| Sasso Pisano | 1 × 3500 = 3500 kw | 2 × 3500 = 7000 kw |
| Lago | 1 × 300 = 300 kw | |
| Monterotondo | | 1 × 3500 = 3500 kw |
| Larderello No. 3 | | 4 × 26,000 = 104,000 kw |
| Total | 16 sets 135,800 kw | 21 sets 254,500 kw |

Economically, these natural steam power plants are very important because the flow of steam is continuous and the plants are used almost at unity. On the other hand, the hydroelectric plants, which today produce about 94 per cent of Italy's electric power, are not reliable. In the recent past, lack of water has forced many industries into periodic shutdowns during the dry season.

Industrial recovery is impossible without sufficient electric energy. During the prewar period, production of electric power was almost enough to cover the demand of 20 billion kwhr per year. However, the 22.7 billion kwhr produced in 1949 were insufficient to meet the requirements of a potential estimated demand of about 25 million kwhr.

It is hoped that new and powerful fumaroles will be drilled with American equipment and that electric power generated in Italy will be considerably increased with natural steam.

### ACKNOWLEDGMENT

The author wishes to acknowledge the book "I Soffioni Boraciferi Toscani e Gli Impianti della Larderello" (The Tuscan boric fumaroles and the plants of the Larderello Company) by Alfredo Mazzoni, general manager of the Larderello Company, and to thank him for all the data and material used in the present report.

# DESIGN *of a* SEMIAUTOMATIC GAGING-*and*-SORTING MACHINE

By GEORGE M. FOSTER

NORTHERN ELECTRIC COMPANY, LTD., MONTREAL, QUEBEC, CANADA. MEMBER ASME

## INTRODUCTION

PRODUCTION quantities of manufactured articles in Canada, as in any country, are limited by the population and purchasing power of the people. In comparison with that for American markets, Canadian manufacture is relatively small, and in most fields, cost of production is higher because of the limit on capital expenditure possible.

These limitations apply in the manufacture of telephone equipment, with the further established policy in the company with which the author is connected, that the cost of any item must be such that it cannot be purchased in Canada, or imported, for less.

The result is that we are forced to engineer in such a manner as to meet these conditions and company policy and, of necessity, to evolve methods using work simplification to the utmost, and to apply very careful consideration to design and cost of tooling.

To demonstrate our approach to the problem, let us consider a machine for gaging, and for sorting out the defectives, on a part known as the "protector block," a device used to protect telephone instruments from damage, and telephone users from harm, should a line carrying power come in contact with a telephone line.

## THE PROTECTOR BLOCK

The annual production of protector blocks is about 2,000,000, a relatively low quantity as compared with American production. Fig. 1 shows the protector block for the inspection of which the machine to be described was designed. The part consists of a ceramic block in which there is a carbon insert, held in place by a lead-borate cement. The porcelain, an insulator, is a mixture of several kinds of clay and of feldspar. It is pelleted and is fired at 2380 F. The carbon insert, a conductor, made of coke, coal-tar pitch, and lampblack, is also pelleted and is fired at 1500 F. The lead-borate cement, applied in powder form, runs in at 1200 to 1300 F.

The whole block is not very large, has a rather frail section, and is brittle and fragile.

Fig. 2 shows how the No. 27 block fits into the complete protector which is used to avoid injury to a telephone subscriber or his set, should a power line come in contact with the telephone line. It also functions should his line be struck by lightning, or pick up a static charge.

Fig. 3 shows the complete protector and some of the constituent blocks. On the molded base are mounted the fuses, with a connecting pair of terminals at lower left for the incoming line to the fuses and another pair from the fuses to the telephone instrument. The top-center screw and nut is the connection to ground.

Two No. 27 porcelain blocks, one for each side of the line, are pressed by the contact springs against two mating No. 26 carbon blocks and these against a common ground plate. The molded cap screws into the base to act as a cover.

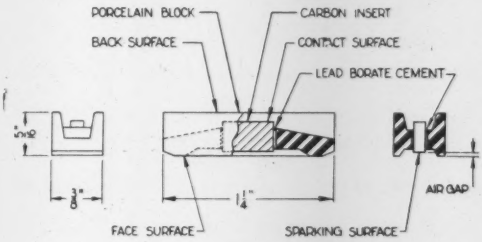


FIG. 1 NO. 27 PROTECTOR BLOCK

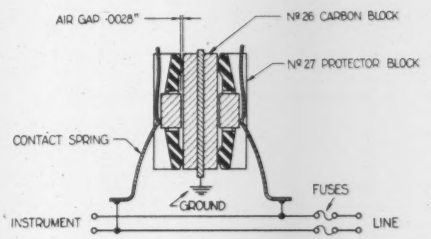


FIG. 2 TELEPHONE PROTECTOR

The smaller No. 29 block shown is used under different conditions but is included because it also is gaged on the machine which is the subject of this paper.

Fig. 4 illustrates the dimensions and requirements which are to be gaged and tested and for which the gaging-and-sorting machine was to be designed.

Numbered in the order in which the checks are made, the requirements are as follows:

1 A 15-lb load is applied to the carbon insert in one direction.

2 A 5-lb load is applied in the opposite direction. The insert shall not move under these pressures.

3 A dimensional check of the distance from the face of the porcelain block to the spring-contact surface of the insert is necessary to insure uniformity of spring pressure.

4 The side wall of the porcelain block above the insert acts as a guide in assembly, and must be checked for height.

5–6 Location of the sparking surface in relation to the face of the porcelain is to be gaged.

Contributed by the Machine Design Division and presented at the Semi-Annual Meeting, Toronto, Ont., Can., June 11–15, 1951, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

FIG. 3 COMPLETE PROTECTOR AND CONSTITUENT BLOCKS

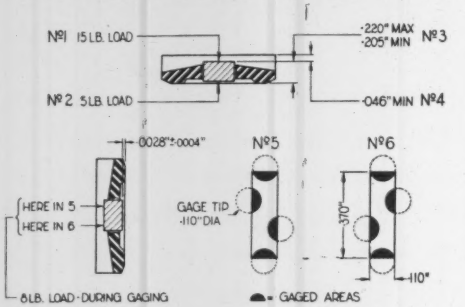


FIG. 4 DIMENSIONS AND GAGING REQUIREMENTS OF NO. 27 BLOCK

Note that the 0.0028-in. dimension is held to plus or minus 0.0004 in. on a surface 0.110 in. × 0.370 in. and that four places on each block are gaged. During this gaging, an 8-lb load is applied on the spring surface of the insert with a 1-lb pressure on each of the gaging plungers.

### DEVELOPING INSPECTION FACILITIES

The first step taken toward the provision of inspection facilities for the requirements, shown in Fig. 4, was to consider just how the inspection could be done, what gages would be required, and what the cost of inspection would be for the 2,000,000 blocks per year.

Production methods were being established on the basis of automatic and semiautomatic machines. This fact, coupled with the importance of the dimensions, particularly those for the air gap and the pressure test, made it imperative that parts be gaged in 100 per cent detail.

Three analyses were made, with tentative designs of gages, and their costs and productive rates estimated.

The first analysis, based on hand-loaded and hand-operated gages, revealed that these would cost $5000, and that the annual inspection time would be 14,000 hr (at 90 per cent efficiency).

A further study showed that inspection time could be reduced to about 7000 hr by partially mechanizing and otherwise increasing the output of the various individual gages. This, however, would increase the cost to $10,000.

Finally, it was proposed to combine all the gages in one mechanized unit in which all six inspection operations would be performed simultaneously. At a speed of operation of 3000 parts per hr, the time would be 1000 hr yearly for the 2,000,000 parts. This time would be one half of one shift, leaving plenty of time for any maintenance which might be required. A cost limit of $20,000 was established as the probable cost, and also as the most capital which would be available.

The cost comparison, illustrated in Table 1, shows that we were justified in deciding to proceed with the design of a multiple automatic gaging machine.

TABLE 1 COMPARISON METHOD VERSUS COST

| | Cost in dollars | | |
|---|---|---|---|
| | | Yearly | |
| Method | Capital | Inspect[a] | Total[b] |
| A | 5000 | 14000 | 15000 |
| B | 10000 | 7000 | 9000 |
| C | 20000 | 1000 | 5000 |

[a] Based on $1.00 per hour.
[b] Includes 20 per cent depreciation and maintenance.

*Design.* A multiple gaging unit having been agreed upon, the next decision to be made was that of the general arrangement of the gaging stations, and the method of conveying parts from station to station. This could be done in one straight line or by a rotating arrangement. The straight-line method would result in a rather long machine and would probably require a return conveyer capable of affording the desired accuracy of location at each station.

A rotating carrier, with nests into which parts could be inserted and indexed to come to rest for gaging on a stationary base, was adopted as being more compact.

Since there are two sizes of blocks, the fact that a ring-shaped carrier could be more readily changed over influenced the decision in favor of a rotating arrangement.

General mechanical requirements for the design of the machine were established as follows:

1 Utilization of standard readily obtainable and replaceable commercial units.

2 Hand-loading which would permit the operator to discard broken and obvious defectives. This to be the only manual feature.

3 A production rate of 3600 per hr, with some lower speed available for trainees, if necessary.

4 Sorting of defectives at each stage.

5 Gaging units or heads to be easily set or adjusted, and retain their accuracy.

6 Accessibility of the mechanism for adjustment and for removability of units for maintenance and cleaning.

7 Controls to permit continuous operation and also single-operation jogging for adjusting to master blocks.

8 Use of carbide and/or chrome plate on surfaces subject to wear.

9 Compactness, convenient operator height, pleasing general appearance.

The sequence of the gaging operations had now to be determined.

The carbon insert is held in place by the lead-borate cement. If the insert be loose, the block is defective. Therefore the 15 and 5-lb pressure tests were selected to be made first, and the most important test, the air-gap requirement, to be made last.

It was planned that, for the sorting action, solenoid-operated drop-out gates would be used. Some form of amplifying limit switch would be required to operate the solenoids, and commercially available units, of which there are a number on the market, were selected.

For three stations, namely, the 15 and 5-lb tests and the minimum 0.046 in., simple unidirectional microswitches were used.

For the 220/205 dimension, a self-contained adjustable gage

was chosen. This device has a high amplification through its reed leverage principle.

For the air-gap requirement (checked twice, each at four spots) air-electric gages were selected. In these, a change in dimension of part being gaged affects air pressure on a Bourdon tube, which in turn actuates the adjustable switch contacts.

Although designed to have the minimum weight possible, there is considerable inertia to overcome in stopping the rotating members. For this reason a reversing motor drive and a zero-speed cutout were utilized, together with an overload clutch.

The succeeding stage in design was to lay out the number of stations required for loading, gaging, sorting, and unloading. This came to 14, but 16 were specified as simplifying design and construction problems. This left two vacant, but later one was used for cleaning and one for a position check.

A Geneva motion was adopted as that best applicable for indexing and locking at each position.

A time chart was prepared to insure maximum dwell for gaging and sorting and yet not accelerate the indexing beyond safe margins. This chart will later be examined in detail.

The loading of this fragile protector block without damage and breakage was studied, and various loading methods were tried out experimentally. The method finally selected was to slide the parts down a chute on a 30-deg incline, with the later addition of air jets which accelerate and simultaneously cushion the part as it slides directly into its nest.

*Construction.* Figs. 5 and 6 are schematics outlining the construction of the machine. In Fig. 5 is shown the carrier table on which is a series of nests into which the parts are loaded, passed around on the stationary ring and presented in turn to the various gages. These nests are removable for repair and for exchanging for the two sizes of protector blocks which are gaged on the machine. Following each gage is a means of ejecting defective parts into pans. A part acceptable to all gages is finally dropped on a conveyer. The main shaft rotates counterclockwise and intermittently, through the Geneva stop mechanism which is driven by the pin in the cam and locked by the half pin on the center of the cam. The cam, driven at 60 rpm, lifts the spider on the center shaft by means of a lever. The spider, in turn, raises all gaging heads simultaneously to clear the parts while they are being indexed.

As each gaging head descends, it clamps the part and helps to lock the carrier table which is rigidly fixed to, and rotates with, the main shaft. Should the part be outside the limits, a gaging switch energizes the memory-pin solenoid.

When the carrier is indexed to the next station, the memory pin, now in extended position, actuates the switch which energizes the reject trap-door solenoid which opens the trap and permits the part to fall into the chute to the pan. This is repeated at each station. The plate under and parallel to the carrier table is rotated with the main shaft and carries the memory pins, of which there are 16.

The plate under the stationary ring and the rubber seal ring keep dirt and dust from falling on the mechanism. The Geneva wheel, the center-shaft lifting mechanism, and cams are all kept in an enclosed oil bath. The conveyer for the accepted parts is driven by its individual 40 to 1 geared-head $^1/_{20}$-hp motor.

The main motor is $^1/_2$ hp and has a reversing feature to effect rapid stopping of the motor and the mechanism. This is accomplished by a reversing switch and a zero-speed cutout, and is controlled by the stop button or the photoelectric tube.

In addition to driving the indexing camshaft, the motor shaft carries three cams, two to operate limit switches, energizing the gaging and reject circuits, and one to operate the air valve which controls the air blast at the cleaning station.

The plan view schematic, Fig. 6, shows the arrangement on

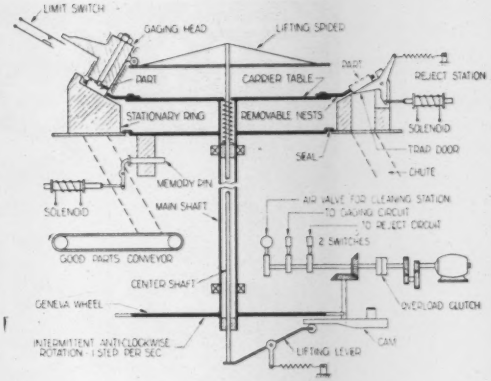


FIG. 5 ELEVATION SCHEMATIC OF MACHINE

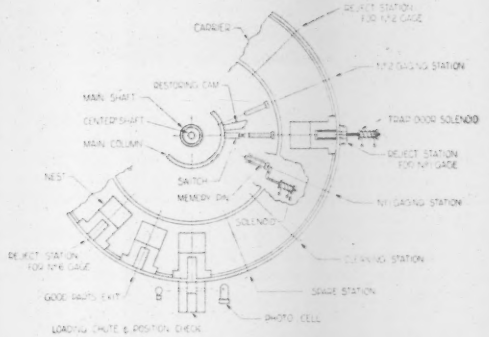


FIG. 6 PLAN VIEW SCHEMATIC CARRIER AND OTHER DETAILS

the carrier plate of the 16 nests, only a few of which are illustrated.

The fragile nature of the porcelain results in a certain amount of chipping in handling. For this reason, parts are picked up and loaded manually to avoid carrying chips into the loading chute.

Should the operator fail to keep the loading chute supplied with parts, the photoelectric cell will stop the machine automatically.

*Operating Sequence.* It was originally intended to check the position of the part at the first station from loading, but a simple protruding pin in the loading chute insured the correct side being up and this station is now a spare.

At the second indexed position, a blast of air cleans out any small particles or carbon dust which may be present.

The third indexed position is the first gaging station, which is that applying the 15-lb load to check for looseness of the insert.

As stated earlier, the order of gaging was established deliberately, with this 15-lb test being first and the air gap last. Obviously, if the insert is loose, or incorrect on the wider limit dimensions, there is no reason to gage further. Wear on the close-tolerance air-gap gages is thereby reduced.

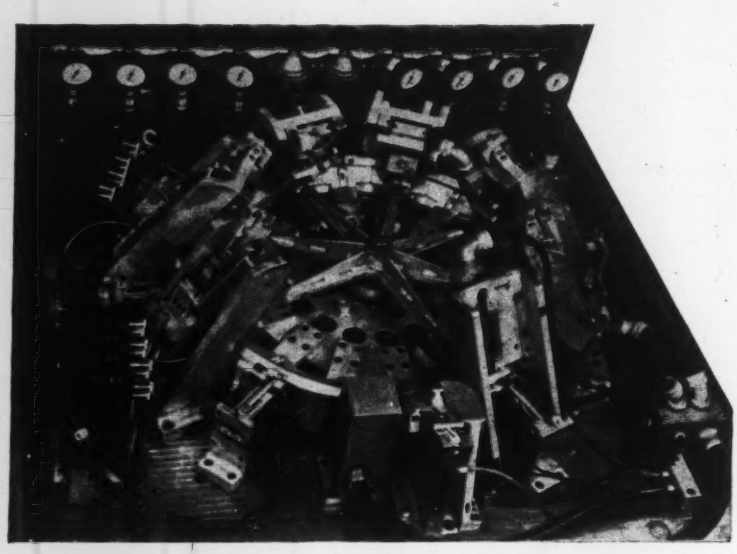

FIG. 7 TOP VIEW, GAGING HEADS AND OTHER DETAILS

The fourth indexing carries the part to a reject station, where it is ejected if proved incorrect at previous gaging.

The fifth is a gaging station, the sixth a reject, and so successively, with accepted parts dropping through the good-parts exit to the conveyer.

Also shown are three of the 16 memory pins, the switch which is actuated by the memory pin at the next, or reject station, and the cam which restores the memory pin to its normal position.

The switch, the cam, and the two associated solenoids are in fixed positions, while the memory pins are indexed with the carrier table.

Fig. 7 shows the spider, each leg of which lifts a gaging head during indexing of the nest carrier plate. The head which was intended to be a positioning check is immediately to the right of the loading chute in front center. At present this head is a spare but is left in place, however, as it balances the spider. Counterclockwise and at each spider leg are the six gaging stations. Immediately after the "spare" head is the cleaning station and following each gaging is a "reject" station. On the left side are the two batteries of four air-electric heads used as part of the air-gap gaging in stations Nos. 5 and 6. At the rear are the regulators which control the air pressure to the eight air-electric gages and the eight pressure-indicating gages. Flanking the loading chute is the photocell arrangement.

### TIMING OF FUNCTIONS

In any automatic machine, proper timing of the various interlocking functions of the mechanism is of vital importance. Incorrect design or construction can lead to disastrous results.

In our gaging-and-sorting machine, the operating cycle is 1 sec of time, during which all the various functions are performed. The various controlling cams make one revolution per second and the time chart, Fig. 8, shows just what happens during the 360 deg of rotation.

The indexing of the carrier, moving the protector blocks from one station to the next, occupies 165 deg or 0.458 sec,

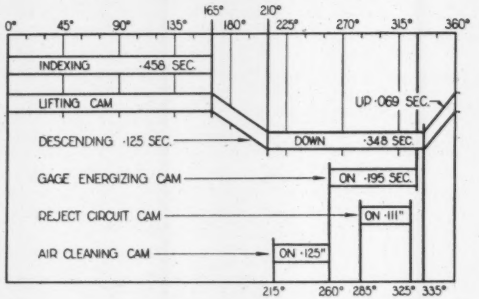


FIG. 8 TIMING CHART, ONE CYCLE

somewhat less than half the whole time. When the indexing is completed, the gaging heads are permitted to descend and the gages contact the part and assist in holding the plate stationary. This takes 45 deg or $^1/_8$ sec.

There is then a lag of 50 deg, less than $^1/_7$ sec, and in this period all the gaging heads come to rest, with the open or closed condition of the various contacts established by the dimensions of the parts. During 45 of these 50 deg, air is blown on the part in the cleaning station. After this lag of 50 deg, the gage-energizing cam then permits current to flow for 70 deg or 0.195 sec.

Twenty-five degrees or about $^7/_{100}$ sec after the gaging current is applied, the reject circuit is energized. This is held on for 40 deg or $^1/_9$ sec, sufficient time to operate the relays and solenoids which, through the memory pins, open the trap doors for rejects.

Finally the lifting cam, in 25 deg, or again $^7/_{100}$ sec, raises all the gaging heads in time to permit the indexing to start again.

The precise timing necessary for the proper functioning of

the machine is not quite the simple matter of energizing the solenoids which have been shown in schematic form.

Many relays were required to set up circuits and to provide short periods of time delay. These relays and other electrical devices are mounted on an electrical panel.

Details of the first gaging station, at which the carbon insert is checked for looseness or improper cementing in the porcelain block, are clarified in Fig. 9.

The lifting spider holds the gage slide up, and through a lever the retracting rod holds the lower gage block down so that the part may be indexed, without interference, to position for gaging on top of the carbide insert, or for rejection, over a trap door. As the spider descends, the gage slide moves toward the part being gaged under the tension of the return spring.

Movement of the lever and the retracting rod allows the carbide gaging tip to come into contact with the lower or sparking surface of the insert. The contacts in the microswitch are opened. As the slide descends further, the 15-lb load is applied to the top surface of the insert. Should the insert be loose or the air gap less than the minimum, the microswitch contacts will be closed. This will actuate the memory-pin solenoid, and at next reject station the defective part will drop through the trap door and down the segregating chute.

The maximum 0.220-in. minimum 0.205-in. dimension is checked at the third gaging station. This gage, Fig. 10, is similar to No. 1 gage, Fig. 9, except that a bidirectional switch replaces the single limit microswitch.

As the head descends the gaging tip is brought against the spring surface of the carbon insert. Fastened to the fixed block are reeds which hold the movable block. Also attached to each block is one of another pair of reed springs which support and actuate the contact-operating arm. This arrangement not only gives a high magnification but is positive in its action. Should the part be over the maximum dimension, the gaging tip will, through the movable block, lift the left-hand reed spring, causing the upper end of the arm to swing to the right. The insulated tip will pass through a slot in the fixed and adjusted contact spring and, by pressing against the other contact spring, will break the circuit to a relay. The relay in turn will then close the circuit to energize the reject solenoid which actuates the memory pin. Should the part be under the minimum, the left-hand pair of contacts function in similar manner.

Sorting at No. 3 gage is more complicated than at Nos. 1 and 2 stations, and is done by a gate below the trap door, Fig. 11.

The contacts shown in upper-left corner represent those of the relays which are actuated by the contacts in the limit switch shown in Fig. 10. These relay contacts, in addition to operating the memory-pin solenoid, also energize the rejection-gate solenoids, which in turn position the sorting deflector.

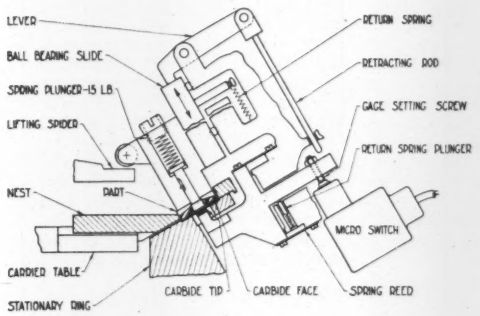


FIG. 9 DETAILS OF FIRST GAGING STATION

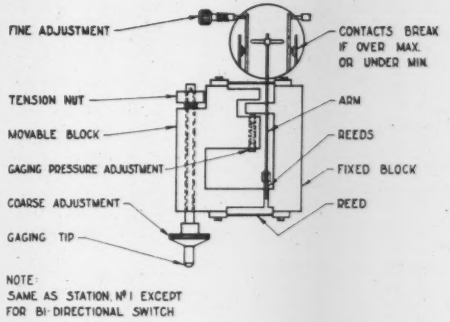


FIG. 10 DETAILS OF THIRD GAGING STATION

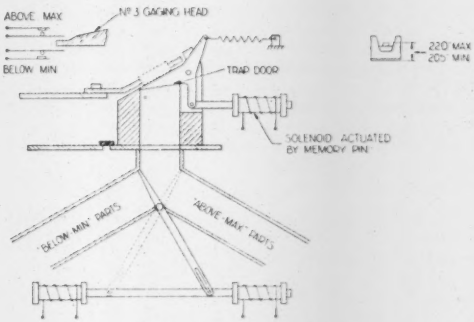


FIG. 11 REJECT MECHANISM AT THIRD GAGING STATION

The gaging of the air gap is nearly identical in stations Nos. 5 and 6 and is portrayed in Fig. 12. Bilateral tolerances of plus or minus 0.0004 in. have to be checked at four spots on a surface less than $\frac{1}{8}$ in. wide × $\frac{3}{8}$ in. long. Because of the close grouping of the four gaging tips, an air-operated electric gaging head was used. Each of the four gaging plungers is fastened to a separate movable reed block. Each associated fixed reed block has an air-escape jet, the air flow being controlled by the position of the movable portion of the gage.

Tracing the action, compressed, dried, and filtered air, regulated to about 35 psi pressure, is fed through a manifold and piece of flexible tubing to the fixed gage block, where it escapes at a rate determined by the position of the movable block.

The air-electric head, mounted on the manifold, has a Bourdon tube connected to the air. Because of constriction in the diameter of the air line and the escape, the pressure in the Bourdon tube is about 15 psi. To the Bourdon tube is fastened a contact operating arm. As the volume of the air escaping varies with the location of the gaging plunger, so the pressure in the Bourdon tube is varied. A differential pressure of only 2 or 3 psi is sufficient to actuate the arm and the contacts, and through the latter and its associated relays, the reject and sorting mechanism.

The completed machine is shown in Fig. 13. The black panel at the back is, in effect, a drawing of the block and the dimension gaged at each station with a light associated with each dimension. The lights are used for setting and adjusting to

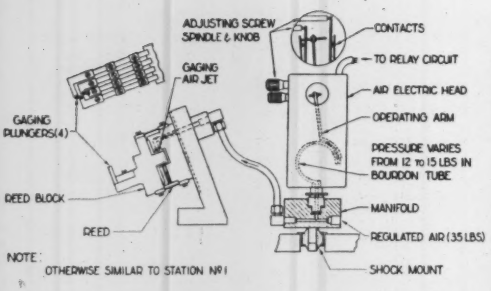


FIG. 12 DETAILS OF AIR-GAP GAGE AT STATIONS NOS. 5 AND 6

the master gage blocks which are in the open box lying on the right front corner. Directly under the box is the control panel while the small elevation in the center of the removable tray is the entrance to the loading chute.

On the lower left side are four chutes with pans for receiving defectives and above these is the end of the conveyer for the good parts. It is intended that these be carried out to a bench for visual inspection and packing, but, in the illustration, the accepted parts drop into a pan. The gaging heads are under a hinged transparent cover, permitting their operation to be observed or exposed for adjustment.

### CONCLUSION

Such devices, as this gaging-and-sorting machine, through increasing production and reducing cost, are important factors in our standard of living and way of life.

As engineers we should continue to design and provide automatic and laborsaving machinery. We must not overlook the need for training personnel to build, adjust, and maintain machines of this type. Those assigned to this work find it interesting and intriguing, and the training problem will not be found too difficult.

FIG. 13 THE GAGING-AND-SORTING MACHINE

### ACKNOWLEDGMENT

The Sheffield Gage Company, which constructed this gaging-and-sorting machine, was responsible for design to the specifications established. Appreciation and thanks are due, particularly to the engineering staff of that company, as well as to associates in the author's company, for making this paper possible and assisting in its preparation.

## Continuous Sampling Monitor

A NEW electrical device developed to aid quality-control engineers in continuous sampling was recently announced by the General Electric Company, Schenectady, N. Y.

In contrast to the company's quality-control indicator, made available last year for application where 100 per cent inspection is desired, the new instrument is for use where the sampling method is preferred.

The "continuous-sampling monitor," as the new device is called, was designed to eliminate the complexity of paperwork inherent in the continuous-sampling methods of quality control.

In operation, a given number of consecutive acceptable units is established by 100 per cent inspection. This "clearance" number, and the percentage number to be used for sampling, are determined by the desired average outgoing quality level (AOQL), selected from a set of curves supplied with the equipment.

When the clearance number is reached, sampling begins. The prescribed percentage of units is inspected until an unacceptable unit is found. This defective unit is replaced by a good unit, and the 100 per cent inspection is followed again until the clearance is reached, at which time sampling resumes. This procedure continues; each time a reject is found, it is replaced with a good unit, and 100 per cent inspection is followed until the clearance number that should obtain is re-established

To operate the monitor, the inspector pushes one of the two push buttons—labeled "accept" and "reject"—after each inspection. He then follows the directions shown by one of two indicating lights; he inspects every unit while the red light is on, and samples while the white light is on.

Briefly, the monitor works in this way: An electric counter, set to any predetermined number from 1 to 400, automatically keeps track of the clearance number. When the counter reaches the set number, contact is broken, and the white sampling light goes on indicating that the predetermined number of acceptable units has been inspected, and that sampling can resume. Percentage inspection or sampling may vary from 1 per cent to 50 per cent depending on the desired AOQL.

The monitor is contained in a small cabinet approximately 12 in. × 6 in. × 6 in. The control box, located so that the inspector can easily operate the pushbuttons and read the indicator lights, is 4 in. × 4 in. × 2 in. and is connected to the monitor by a multiconductor cable. The monitor requires 110 volts and has a maximum counting speed of 500 units per minute.

The new device was shown publicly for the first time at the American Society for Quality Control Show, held in May, 1951, at the public auditorium in Cleveland.

# *Competing With* NATURE'S HAND

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## INTRODUCTION

THE human hand has a sense of touch, it assists as temperature control for the rest of the body, it is an essential part in the normal appearance of an individual if not an expression of character, and, by various combinations of some 39 independent movements, is capable of performing the multitude of manual tasks so essential in effecting the physical interpretation of man's mental productivity.

The goal is established. How can this marvelous mechanism of nature be reproduced in an artificial appliance for the hundreds of veterans of two world wars who have sustained the loss of one arm, or in some cases both arms? Obviously, great compromises must be made to bring the problem to within the limits of scientific skill and reasonable economy.

Although remarkable advances have been made recently toward the development of battery-powered prostheses, it seems advisable that, for general use, the energy for operation of an artificial appliance be produced by the amputee. This is usually realized by the use of a shoulder harness which produces a tension force up the arm in a manner similar to the movement of one's shirt cuff upon reaching forward. In a few cases, skin-lined tunnels have been surgically formed through suitable muscles to which prostheses may be harnessed directly. In either case, since provision may be made for elbow flexion and wrist motion, there is normally only one energy source available for operation of the hand and that in the form of a force of about 30 lb moving up the arm through a displacement of about $1^1/_4$ in.

From observation, functional limitations are clearly shown—instead of 39 independent sources of energy we normally have but one. As most of the functions of the hand involve grasping, it is logical then to direct this energy to effect prehension which is essentially drawing together the fingers and the thumb. The sense of touch and the sense of temperature are lost and so appearance is the only remaining characteristic to be considered.

Making use of modern plastics it is possible to provide a material similar in appearance to human skin with adequate flexibility and suitable resistance to wear and discoloration. Probably the best material currently available is a polyvinyl-chloride acetate. The production of these skinlike cosmetic gloves lies in the construction of suitable molds which faithfully duplicate all the lines and form of the human hand. The technique adopted for this procedure will be described in a later section of the paper.

Having examined the problem from a standpoint of function and appearance, one further point should be mentioned. At first thought it might seem desirable to duplicate the weight of the normal hand, but, in fact, the lighter the prosthesis can be made, the more acceptable it will be. Anyone who has ever tried dancing while wearing heavy boots will appreciate the difficulty and discomfort experienced by an amputee in maneuvering a heavy artificial appliance in performing a routine task, to say nothing of carrying around excess dead weight all day. This is of particular importance to a hand since it is at the extremity of the artificial arm and hence contributes a greater moment.

The standard arm as supplied to a war amputee is equipped with a quick-release adapter so that either a wooden dress hand or a functional split-type hook may be interchanged readily. Consequently, the same adapter has been utilized in the new hand as a mounting plate for the mechanism. The design of the hand has been resolved into three components, the mechanism, the framework or hand structure, and the skinlike cosmetic glove. In this way the mechanism may be standardized for all hand sizes and the cosmetic glove, subject to wear, tear, and eventual discoloration, may be readily replaced.

## THE MECHANISM

In the simplest type of artificial hand, the control cord is fastened directly to the fingers and a pull on the cord opens the hand against the action of a spring. The criticism of this type lies in the fact that the force exerted by the spring is constant and hence the grip cannot be varied. As an alternative, the control cord may be attached so as to close the finger against a light spring, but a force must be exerted as long as a grip is to be maintained. The logical development is to provide an automatic lock which holds the fingers rigidly in any position with unlocking effected by a subsequent pull on the control cord. Thus a lock and some sort of cyclic mechanism is involved. This is essentially the pattern adopted in designing the mechanism.

The principle of the operation is pictorially described in Figs. 1 to 6, and reference to Fig. 1 will indicate the essential parts, which are as follows:

(A) Control cord to operate mechanism.
(B) Unlocking arm pivoted about pivot (E).
(C) Unlocking pawl pivoted on unlocking arm (B).
(D) Spring—three purposes as follows: (1) Retains pawl (C) in position shown in Fig. 1; (2) keeps pawl (G) firmly against arc (H); (3) Forces arm (B) away from arm (F).
(E) Pivot joining arm (B) and arm (F) to base plate of hand.
(F) Locking arm—pivoted about pivot (E).
(G) Locking pawl—pivoted on locking arm (F).
(H) Arc—anchored to base plate and concentric with pivot (E)
(J) Link joining locking arm to fingers.
(K) Finger extension spring—forces hand open.
(L) Finger pivot.

Figs. 1 to 6 illustrate each step of the locking cycle, and the following tabulation describes the function of each part in detail. The operation described actually takes place during one simple pull of the control cord.

*Locking Cycle:*

Fig. 1 shows hand in open relaxed position.

Fig. 2 shows control cord in motion due to a pulling force. Unlocking arm (B) is advanced against action of spring (D) until unlocking pawl (C) contacts locking pawl (G).

Fig. 3 shows control cord continuing motion—unlocking arm (B) further advanced until unlocking pawl (C) has caused

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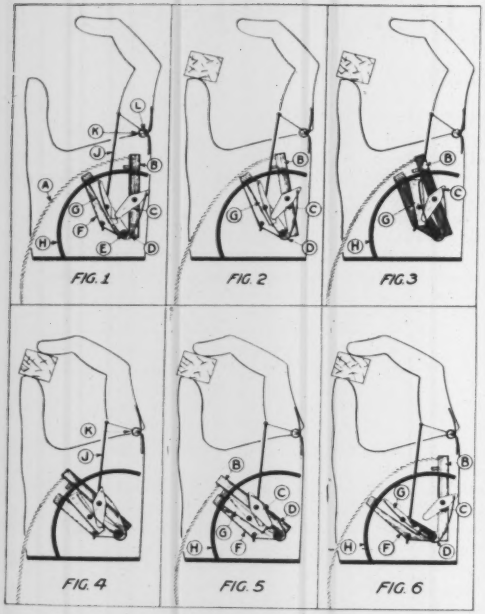


FIGS. 1 TO 6 SCHEMATIC DIAGRAMS SHOWING HAND-OPERATING MECHANISM

locking pawl (G) to rotate about its own axis to position shown. This is unlocked position since locking pawl (G) has moved away from arc (H) so that the arc is free between the locking pawl and the end of the locking arm.

Fig. 4 shows control cord continuing motion. The unlocking arm and pawl, and the locking arm and pawl have the same relative positions as in Fig. 3, but have advanced together to a new position where the fingers have been drawn by link (J) to grasp the block, against action of spring (K).

Fig. 5 shows control cord after completing travel. Owing to resistance of block, locking arm (F) cannot advance. Unlocking arm (B) advances until unlocking pawl (C) rotates about its own axis against resistance of locking pawl (G). Stop on unlocking arm (B) contacts locking arm (F) and locking pawl (G) freed from unlocking pawl (C) rotates due to spring (D) until it contacts arc (H) pinching the arc against the end of the locking arm (F).

Fig. 6 shows pulling force on control cord relaxed—fingers locked on block. Spring (D) causes unlocking arm and unlocking pawl (C) to rotate to position shown. Fingers cannot return to open position since locking arm (F) is clamped to arc (H) by locking pawl (G).

The unlocking cycle is performed by a subsequent pull on the control cord from a position as shown in Fig. 6, to a position shown in Fig. 4, where the unlocking pawl (C) has engaged the locking pawl (G) causing it to rotate to the unlocked position. The pull on the control cord is then relaxed and finger extension spring (K) causes the hand to open, forcing locking arm (F) and consequently unlocking arm (B) to retire to the position shown in Fig. 3. The fingers have reached the end of their travel, hence the locking arm (F) remains as in Fig. 3. However, spring (D) causes unlocking arm (B) to move to the relaxed position as in Fig. 1, which disengages unlocking pawl (C) from locking pawl (G), allowing pawl (G) to return to the locked position under action of spring (D) shown in Fig. 1.

There are variations to the locking cycle as described. Upon unlocking, it is not necessary to allow the fingers to return to the fully opened position before relocking, and if desired a quick pull on the control cord will cause the mechanism to go through the unlocking cycle and directly into the locking cycle without opening the fingers. This enables the amputee to tighten his grip if desired. Further, referring to Fig. 5, if the object grasped is resilient, then the fingers may be drawn up after the lock has been engaged, although some friction loss will be experienced. This is possible since a stop on the leading edge of the unlocking arm prevents the unlocking pawl from jamming the locking pawl against the arc when in the position illustrated in Fig. 5.

It will be noted that the lock is of the friction type and the essential feature lies in the geometry of the locking pawl relative to the arc. If the angle formed by the line joining the locking pawl pivot to the point of contact with the arc, and the normal to the arc through the locking pawl pivot, is less than the angle of friction, then no slipping will occur.

As both the arc and the locking pawl are steel, the angle of friction is about 6 deg and in service the actual angle made by the locking pawl is about 4 deg. Since the finger excursion is about double the locking-arm excursion, a fingertip load of 50 lb will exert a tangential force of 100 lb at the point of contact. The normal force at the point of contact will then be 100 lb, divided by the tangent of 4 deg or something in the order of 1500 lb. This normal force is resisted by bearing of the pawl on the arc at the line of contact and by the locking-pawl pivot. Service tests have shown that satisfactory results have been obtained using a normalized chrome-molybdenum-steel arc (×4130) and a cyanide-hardened mild-steel pawl mounted on a 5/32 carbon-steel pivot. Adjustment to take up wear and machining tolerances is provided by a shoe fitted between the arc and the locking arm which can be shimmed as required. However, since wear can take place to the extent of 0.003 in. without malfunction of the mechanism, it is not expected that wear will be a serious problem.

The locking and unlocking arms and the base plate on which they are mounted are machined from 75S-T bar stock, while the bayonet and the pawls are cyanide-hardened mild steel to obtain maximum surface hardness without brittleness.

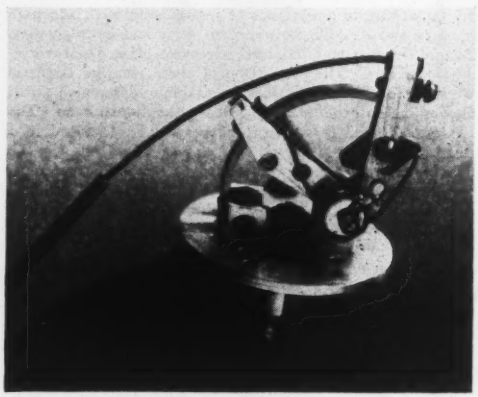

FIG. 7 THE ASSEMBLED MECHANISM

The control cable is standard $^1/_{16}$-in. stainless-steel aircraft cable and, in the first models, the mechanism is linked to the fingers by similar cable and anchored by aluminum-alloy plugs at the fingertips, threaded to provide adjustment. Both the mechanism spring and the finger-extension spring are wound from music wire without heat-treating.

In order to allow reasonable manufacturing tolerances, further adjustment is made available through eccentric pivots for mounting the arc and the unlocking pawl.

Fig. 7 shows the assembled mechanism mounted on the base plate and adapter. This unit is readily inserted in or removed from the hand structure and represents the working part of the hand as a whole.

### THE HAND STRUCTURE

Prehension or gripping can be obtained by motion of the fingers, of the thumb, or both. The fingers themselves may be fully articulated and may be differentially connected, which allows the fingers to assume the shape of the object grasped. To provide the essential gripping function together with utmost simplicity and lowest possible weight, it was decided to pivot the fingers at the main joint only so that they move as a unit relative to a fixed thumb. Therefore, both the finger section and the thumb and palm section must be made rigid, and the palm must be hollow to house the mechanism.

In choosing a suitable material, metal was eliminated owing to the high cost of dies in various sizes. To provide an easily and cheaply fabricated unit with strength-to-weight properties and shock resistance comparable to metal, a resin-bonded glass-cloth laminate was chosen. Various polyester and similar resins are commercially available for this purpose, and the resulting product seems satisfactory in every way.

Finger articulation was solved by using a $^3/_{16}$-in. dural rod bearing directly on the plastic components. The hand structure is mounted directly on the base plate as shown in Fig. 7, using four machine screws. To provide an anchor for the screws two nylon plates are embedded in the shell and are jig-drilled to match the base plate. The screws are self-tapping in the nylon plates and require no stop nuts and may be used over and over again with complete satisfaction.

Owing to the complex shape of the human hand, it is very difficult to build satisfactory collapsible mandrels over which the plastic laminate can be formed, consequently the lost-wax method has been used. Wax forms are produced from inexpensive plaster molds and the glass cloth, cut to a pattern, is laid up, and covered by an outer layer of jersey cloth. The resin is then painted well into the cloth. The wax chosen for the job is a microcrystalline high-melting-point wax (about 190 F) which does not react with the resin. The wax also shrinks considerably upon solidifying, enabling it to be removed readily from the mold in which it was cast.

Various steps in the fabrication are shown in the accompanying illustrations. Fig. 8 shows the wax after the glass cloth has been wrapped and the nylon jersey cloth pulled over. The nylon cloth holds the loosely woven glass cloth in place and provides a more suitable surface finish. A jig plate has been attached to the base of the hand to insure a perfect fit with the base plate, and the nylon plates have been embedded in the folds of the glass cloth beneath the flat segments of the base of the hand. Note also that a positioning pin has been placed through the wax to produce holes for the axle at the knuckles. In Fig. 8 the plastic resin is being applied with a paint brush. When this is completed the whole is placed in an infrared oven until the plastic is set, though not necessarily cured. The base plate is then removed and the remainder is put back in the oven where the wax melts and drains away as the resin cures. About $^1/_2$ hr is required for this operation. When the laminated structure is free of wax, the surface is buffed on a sander. The structure is strong enough to hold a man's weight and may be dropped from a height of 20 ft onto concrete without fear of damage and yet it weighs less than $2^1/_4$ oz.

FIG. 8 APPLYING RESIN

FIG. 9 ASSEMBLED HAND SHELL WITH MECHANISM

Veins may be added to the back of the hand by laying on resin-impregnated string and then curing. The fingers are made in an identical manner and are attached to the palm as shown in Fig. 9. In this illustration the hand has been completely assembled and painted ready for fitting the cosmetic glove.

### THE COSMETIC GLOVE

The problem of producing cosmetic gloves begins with the construction of suitable molds. In this particular field electroformed molds are an obvious choice—providing intricate detail at low cost.

The first step is to obtain suitable donors. Experience indicates that artficial hands should be somewhat smaller than normal hands to create the best appearance. Small, medium, and large in lefts and rights seem to cover an adequate range for men.

The next step involves obtaining a latex impression of the donor's hand. The hand is first wiped with silicone grease dissolved in carbon tetrachloride to prevent the hair from adhering to the latex. Then, with the hand held in the correct position, it is immersed in liquid latex, withdrawn and held before a bank of infrared lamps. The first layer of latex is thus

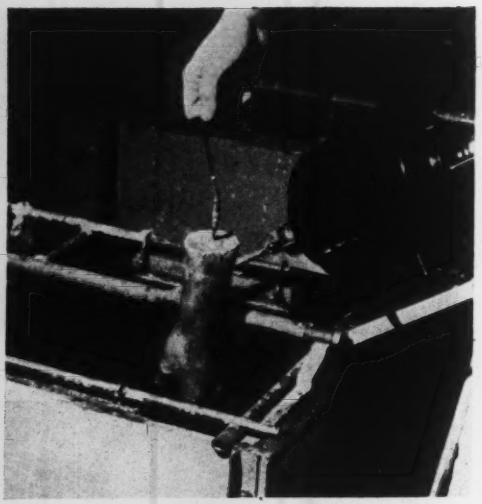

FIG. 10 COPPERPLATING THE METAL POSITIVE

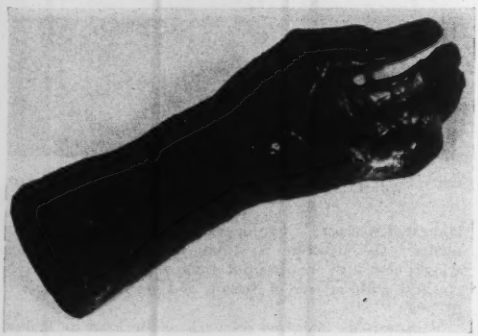

FIG. 11 COMPLETED MOLD

partially cured, and further layers are then applied in identical manner until the thickness reaches about $^1/_{16}$ in. or better. This process takes about 2 hours and is extremely tedious, but excellent impressions are obtained and once taken will serve indefinitely.

The latex is best if allowed a day or so to air-dry after stripping from the donor. A layer of dental stone is then applied to the outside and allowed to harden to provide support for the latex. Further support is gained by burying this in a pot of sand. This precaution is necessary for hot metal is then poured into the mold. The metal used is an alloy of bismuth, lead, and tin and has a melting point of about 200 F. After it has solidified, the dental stone is broken away, and the latex impression stripped off leaving a metal duplicate of the donor's hand.

Fig. 10 shows this metal positive being lowered into a copperplating solution. A copper sulphate-sulphuric acid solution is used, and plating takes place for about 2 days at potential of 2 volts. About $^1/_{16}$ in. copper is deposited in this way, except between the fingers and in the palm where the concave shape of the hand prevents proper plating. After the metal has been melted out in hot glycerine, solder is flowed between the fingers and over the palm to strengthen the mold. This soldered area is shown in the completed mold, Fig. 11. The mold cavity is, however, still quite dirty and usually about a half dozen gloves must be taken from it before it is completely clean. The mold must be lubricated with silicon grease dissolved in carbontetrachloride after each dozen gloves have been obtained.

In producing gloves, two mixes of polyvinyl chloride acetate (PVCA) are used. The first mix is opaque and approximately flesh-colored; the second is nearly transparent and lighter in color. Before using, the plastic is placed in a vacuum tank to remove any air trapped during mixing. The first mix is then poured into the mold, then dumped out. About 1 hr is allowed for draining. In this time the plastic has drained thin from the high spots in the mold, but remains sufficiently thick in the crevices to form opaque areas coincident with the areas between the lines of the skin. The PVCA is then set up by placing the mold in an infrared oven for several minutes. The second, translucent mix is then poured in and the mold is placed in the vacuum tank to remove all air bubbles. Air is pumped from the tank to produce a pressure of about 1 mm inside. Upon removal, with the plastic still inside, the mold is placed in boiling water for 30 sec. This causes a uniform layer of PVCA to set up, and the remainder is drained away. Curing is then effected by immersing the mold in a glycerine bath at a temperature of 150 C for about 2 min. The mold is then washed quickly in water, and the glove is drawn from the mold. No additional coloring is added to the glove, but fingernails are simulated by applying colored PVCA and curing in glycerine at about 190 C. Trimming the open end of the glove with scissors

(*Continued on page 726*)

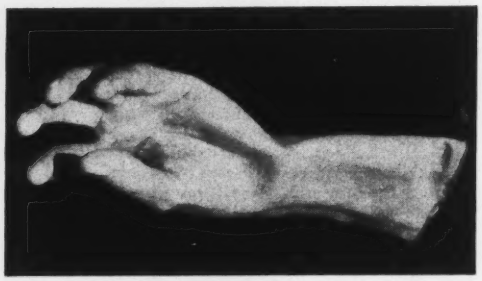

FIG. 12 COMPLETED COSMETIC GLOVE

FIG. 13 COMPLETED HAND

# APPLIED MECHANICS *From* ARISTOTLE *to* RANKINE

By JESSE ORMONDROYD

UNIVERSITY OF MICHIGAN, ANN ARBOR, MICH. MEMBER ASME

THE most satisfactory definition of mechanics was given by Kirchhoff in 1876. To paraphrase this famous definition, "Mechanics is the science of the motion of material bodies. Its problem is to describe all the motions which appear in nature completely and in the simplest manner."

A science is a body of knowledge, expressed in words or mathematical symbols (and, therefore, communicable), deducible from a small number of principles suggested by experience. The science of motion deals with the changes in position, orientation, size, and shape of bodies. Theoretical mechanics has the problem of discovering and stating the concepts, definitions, and relationships which will make the description of motion as simple as possible. Applied mechanics uses the science of motion to satisfy the practical desires of man. All theory grows out of practice and merely makes that practice more understandable, more communicable, and more efficient. Theory is the distilled essence of practice. The most important characteristic of accurate description is its usefulness in the prediction of future events based on the experience of past events.

Theoretical mechanics was developed by men whose main motivation was intellectual curiosity, but they all were stimulated by the current practical interests of their times. Practice always precedes theory. It must always precede it, since theory consists merely of the clearly recognized principles of practice. Practice, theory, better practice, better theory—this is the story of development in every scientific field. It is a fact in the history of mechanics that all the books which mark the milestones of its progressive development contain a small amount of theory and a large number of specific applications of the theory to problems of practical interest or potential practical interest. I need only remind you that the very first work in "scientific" mechanics was done by Archimedes in Sicily around 250 B.C. on the principle of the lever and the hydrostatics of floating and submerged bodies.

This is not the place to give a detailed history of the development of mechanics. I wish only to bring to your attention five books on mechanics which emphasize practice and which are seldom read by engineers today. These are (with approximate dates): "Mechanical Questions," by Aristotle, 350 B.C.; "De Architectura," by Vitruvius, 50 B.C.; "Experimental Enquiries," by Smeaton, A.D. 1780; "Theory of Simple Machines," by Coulomb, A.D. 1790; and "Applied Mechanics," by Rankine, A.D. 1858. All these books are available in any good library, and all are available in English, except the work of Coulomb.

### ARISTOTLE'S 35 MECHANICAL QUESTIONS

The "Mechanica" of Aristotle consists of a short preface plus thirty-five questions concerning balances, levers, wheels, wedges, dynamics of moving bodies, and several questions which cannot be classified under these heads. The author does not group them in any orderly fashion. He does not exercise that "restraint which marks the master" or he would have asked one question and pursued that one question to the bitter end. All the questions, but one, still make sense, and all, but that one, can be answered by modern mechanics. In one sense none of the questions can be answered, because the persistent question throughout the work is "why?" Galileo was the first man to state boldly that no one could ever give a reason "why" events in nature occurred as they did occur. He even pointed out that we wouldn't be any better off if that question could be answered. Since Galileo, science has only asked "how?"

In the dynamical questions the author of the "Mechanica" is hovering on the edge of discovering the law of inertia. Nearly 2000 years later Galileo supplied the answers to these questions by enunciating what is now known as Newton's First Law of Motion.

Among the many amazing things in the treatise are the first verbal statements of the law of the lever (usually attributed to Archimedes a hundred years later), the law of virtual velocities, and the law of parallelogram addition of velocities. It must be remembered that practical men had been using the law of the lever intelligently for countless ages before Aristotle's time. They just never took the trouble to state it clearly in words or in mathematical symbols. But the concepts of virtual velocities and vector addition had to wait 2000 years before anyone else would use them again.

The author states one general principle—the law of the lever—in the beginning and proposes to use it in answering the subsequent questions. He is not too consistent in its use. About half of the questions cannot be answered by the use of that principle. Some of those which are answered by the application of the principle are answered so mistakenly. Many of the perplexities of a mind searching out answers to questions never asked explicitly before are shown clearly in this work. Two of the questions indicate one of these perplexities, "... the very same weight, which one cannot move at all without a lever, one can move quite easily with it, *in spite of the additional weight of the lever*." And again, "How is it that dentists extract teeth more easily by applying *the additional weight* of a tooth extractor than with the bare hand only?"

Perhaps the most amusing part of the book, aside from some of the inept answers (which we can more than forgive in such a pioneer), is the opening discussion. Here we have one of the earliest definitions of mechanics; it is an art by which we do things "contrary to nature." And here we have the more marvelous properties of the circle given as the reason for the less marvelous properties of the lever. "... for there is nothing strange in a lesser marvel being caused by a greater marvel." The marvelous properties of the circle are given as follows: "It is formed by motion and rest, things which are by nature opposed to one another"; the line which encloses the circle is at one and the same time both concave and convex;" "it moves in two contrary directions at the same time." The elucidation of these riddles you will have to gain by perusing this masterpiece for yourselves. Your final chuckle will come as you think of the great philosopher in deep and baffled perplex-

An address, somewhat abridged, presented at the annual dinner, Nov. 28, 1950, New York, N. Y., of the Applied Mechanics Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

ity contemplating the one question in the whole book which modern mechanics is still unable to answer, "Why do they always make beds twice as long as they are wide?"

This little book makes more sense to us than all the rest of Aristotle's physical treatises. If the author had had a few friends to argue with him, he might have anticipated Galileo by 2000 years. Galileo took some of Aristotle's questions quite seriously and found means of answering most of them. But even he was baffled by the question: "Why is it that an axe does not cut wood if it be loaded with a heavy weight and its edge placed on the wood, whereas it splits the wood if struck upon it:" He changed the question to that of pile driving; and in the Fifth and Sixth Days of his "Two New Sciences," retired from the field defeated by this problem of impact and the distinction between static loading and dynamic forces.

### VITRUVIUS—ROMAN ARCHITECT AND ENGINEER

Another book which has come down to us from antiquity provides curious and instructive reading for a couple of idle evenings. "De Architectura," written by Vitruvius around 50 B.C. in Rome, is the only technical treatise that has survived the wreckage of the Roman Empire. It has been translated into numerous languages, including English, and was studied in the schools as recently as the eighteenth century. It contains no mathematics; it is descriptive in nature, but carefully descriptive. For an engineer it will bring the classical civilization to life in a way that no work of standard history can match.

Vitruvius worked either for Julius Caesar or his successor, Augustus Caesar, those two earliest dictators who started Rome on its final conquest of the Mediterranean and European world. Rome had at least 250 years of prosperous expansion before it when Vitruvius lived. It was at the peak of its technical achievements in buildings, roads, aqueducts, ships, and the mechanisms of war.

Vitruvius tells us that the architect not only worked on buildings, but on sun dials, water clocks, the machinery of war, and the mechanisms of peaceful occupations. He also could construct the things he designed. When Vitruvius mentions mechanics, he is thinking of machines. He gives a brief review of the contents of Aristotle's "Mechanica" and tells about the mechanical inventions of Hero and Ctesibius in Alexandria 200 years before his time. For Vitruvius a machine is a device, containing wheels, used to lift and transport heavy weights. An organ he defines as a device for performing useful work which does not contain wheels. His book is filled with technical anecdotes concerning events that go as far back as Alexander the Great.

Vitruvius gives us his concept of an architect (engineer): "An architect should be a good writer, a skillful draftsman, versed in geometry and optics, expert in figures, acquainted with history, informed on the principles of natural and moral philosophy, somewhat of a musician, not ignorant of the sciences both of law and physics, nor of the motions, laws and relations to each other, of the heavenly bodies." If you think you are an engineer "try this on for size."

Vitruvius has something to say about the evils of cost-plus methods of letting contracts. Sometime in a golden age before his own, the city of Ephesus had a law on which he comments: "When an architect was entrusted with the execution of a public work, an estimate thereof being lodged in the hands of a magistrate, his property was held, as security, until the work was finished. If, when finished, the expense did not exceed the estimate, he was complimented with degrees and honors. If the excess did not amount to more than a fourth part of the original estimate, it was defrayed by the public, and no punishment was inflicted. But when more than one fourth of the estimate was exceeded, he was required to pay the excess out of his own pocket. Would to God that such a law existed among the Roman people, for then the unskillful could not commit their depredations with impunity, and those who were skillful would follow the profession."

Public relations were important in the ancient world, even as they are with us. Vitruvius tells us that Dinocrates, a skillful architect, could not bring himself to the attention of Alexander the Great, even though he had friends at court. So he became his own publicity man. "He put off his ordinary clothing, anointed himself with oil, crowned his head with a wreath of poplar, slung a lion's skin across his left shoulder, and, carrying a large club in his right hand, he sallied forth to the royal tribunal just when the king was dispensing justice. His appearance made such a stir in the crowd that Alexander noticed him with astonishment. He ordered the crowd to make way for him and demanded to know who he was." Dinocrates got the job and later laid out the city of Alexandria in Egypt.

The story of Archimedes in the bath comes down to us through the "De Architectura" of Vitruvius.

Vitruvius describes the devices of the mechanized warfare of his time—catapults, scorpions, ballistae, battering rams, and tortises (tanks). The descriptions are meticulous in detail, and, for the most part, totally incomprehensible to us because of the wealth of obsolete technical terms which he uses.

### JOHN SMEATON—"PATRON SAINT" OF APPLIED MECHANICS DIVISION

Let us make a jump of 1800 years—to the middle of the eighteenth century—when the modern profession of nonmilitary engineering was just beginning to crystallize. Watt was inventing the external condenser and starting the Industrial Revolution. Galileo, Huyghens, Newton, Euler, and d'Alembert had already built up the body of theoretical mechanics to the extent that is usually known by modern engineers. Physicists were applying this knowledge in the effort to gain new knowledge, but the few engineers who existed were not yet using it.

One of the greatest of the British engineers of the eighteenth century was John Smeaton. He was a consulting engineer who combined the ability to design and construct in those fields of engineering that we call civil and mechanical today. He was a "philosophical instrument maker" (maker of scientific measuring instruments) and a member of the Royal Society. He designed and built the famous Eddystone lighthouse. He brought the Newcomen steam engine to its highest peak of perfection just about the time that Watt delivered the *coup de grace* to that worthy but inefficient ancestor of all steam engines. Our interest in Smeaton stems from the fact that he was the first British engineer to apply the theory of mechanics to technical problems. He was also the first British engineer to use models for testing purposes. He might well be adopted as the "patron saint" of the Applied Mechanics Division.

In 1752 Smeaton began experimenting with model undershot and overshot water wheels and with model windmills. Smeaton not only designed the models, but he built them with his own hands. In the models were incorporated devices for measuring all the important quantities involved in the experiments. With his windmill experiments Smeaton might lay claim to being the originator of all wind-tunnel experiments on models. His "wind tunnel" was a rotating arm, a device used in more recent years by Langley and the Guggenheim laboratory at Akron, Ohio. Between 1752 and 1759 he incorporated the results of his experiments in many full-sized working water wheels and windmills.

Having satisfied himself that the results of the model tests really worked in full-scale machines, Smeaton began, in 1759, to deliver a series of papers on his experiments before the Royal

Society in London. On May 3 and 10, 1759, he gave his first paper on water wheels; on May 31 and June 14, 1759, his paper on windmills was delivered. The Royal Society was so impressed by these papers that it gave Smeaton a Copley medal, an honor reserved for men in the class of Einstein in these days. On April 25, 1776, he delivered a third paper entitled, "Experimental Examinations of the Quantity and Proportion of Mechanic Power Necessary to Be Employed in Giving Different Degrees of Velocity to Heavy Bodies From a State of Rest." Finally, on April 18, 1782, he gave a fourth paper on "New Fundamental Experiments Upon the Collision of Bodies."

Sometime during the seventeen nineties these four papers were reprinted in a little booklet carrying the title, "Experimental Enquiry Concerning the Natural Powers of Water and Wind." These papers have only historical and antiquarian interest for us today, but in their time they were among the most famous and most quoted papers perused by engineers. When Smeaton wrote the first two papers, the water wheel and the windmill were the only sources of mechanical power available. The Newcomen engine of the time was used only for pumping water out of mines. By the time the collected papers were published, Watt's improved steam engine was beginning to push the water wheel and the windmill into oblivion.

Smeaton found that the undershot water wheel delivered only about one third of the energy carried to it by the water, but that the overshot wheel could deliver about two thirds of the energy available in the water. This settled a long-standing controversy over the relative merits of undershot and overshot water wheels. Smeaton also surmised, after correcting for leakage past the paddles and friction in the bearings, that most of the energy loss in the undershot wheel was due to impact of the water on the paddles, the first mention of "shock losses." He surmised that at least one half of the available energy was lost in this way. This led him in 1782 to make the experiments on the collision of bodies. In the water-wheel experiments Smeaton gave, perhaps, the earliest published definitions of "work," "power," and "efficiency"—three indispensable concepts in the vocabulary of all engineers.

One of the objects of Smeaton's experiments and papers was to bring some order out of the confusion of scientific and technical terms which were used in his time. Even the great Newton wasn't too clear in the use of defined terms. Just try reading his famous three laws in their original form. He meant what we mean today, but he didn't say it the way we say it. He muddies the water with his distinctions between innate force, impressed force, absolute quantity of force, accelerative quantity of force, and motive quantity of force. No wonder controversy raged up to Smeaton's time on the measuring of force. Did it mean mass times velocity? Did it mean mass times velocity squared? Two hundred years after the "Principia" was published, many scientific men used terms like energy and force interchangeably. Smeaton tried to clear up the situation relative to the meaning of force. By reading his reports you will find that impulse, impulsion, impulsive force, power, and impelling force all meant, at different times, something equivalent to a weight. Even Smeaton "fumbled the ball."

In 1759 Smeaton clearly defined power: "The raising of a weight, relative to the height to which it can be raised in a given time, is the most proper measure of power." His calculations in the water-wheel papers show that he meant power to be weight times distance divided by time. But in 1776 he again defined power very clearly as "weight of a body times the height through which it descends." In reading this paper carefully, it can be seen that he really means what we call "work." There is no "silent partner" such as unit time meant to be used in his definition in the third paper. The definitions of work, power, and efficiency were "in the air" of the eighteenth century. The practical men, pumping water out of mines, and hoisting coal to the surface, were using these ideas. Smeaton merely crystallized them.

Smeaton's experimental apparatus appears ingenious to an engineer. A physicist would be horrified at the complication of the same apparatus Although, in the third paper, Smeaton is dealing with the transfer of potential energy of falling weights into kinetic energy of rotation, the definition of energy never occurs to him. Nor does he seem to know anything about "moment of inertia," although Euler had already coined that phrase.

If there were such a thing as retroactive membership in the Applied Mechanics Division, John Smeaton would surely deserve to be number one on the list.

### COULOMB, THE SCIENTIST ENGINEER

If you happen to be French, you will deny that John Smeaton was the founder of applied mechanics. You will say that Coulomb deserves that honor. My only answer would be that Smeaton was an engineer who worked scientifically, while Coulomb was a scientist who was also interested in engineering. I might also say that Smeaton was the older man and had entered the field earlier. But I would have to admit that Coulomb is a formidable rival to Smeaton's claims.

Coulomb, as a scientist, is known as the man who established the inverse-square law of attraction and repulsion between electric charges and magnetic poles. Physicists have honored him by naming the quantity one ampere-second, the Coulomb. But for our purposes he is the man who, between 1779 and 1790, published a series of papers in the proceedings of the Paris Academy of Sciences on a variety of subjects of engineering interest. For some of these papers the Academy of Sciences awarded Coulomb a prize; and in the early years of the nineteenth century these papers were collected in a book entitled "Theory of Simple Machines." If you can read French, you will find this collection of papers highly interesting. It contains his work on friction, starting friction, dynamic friction, friction on pulleys and bearings, pivot friction. Engineers have honored this work by calling the kind of friction which is not a function of velocity "Coulomb friction." He was a pioneer in this field.

One of the most important of these papers, published in 1784, was entitled "Force of Torsion in Metallic Wires." This paper grew out of work on the attraction and repulsion of electric charges and magnetic poles. To do that work, Coulomb invented the torsion balance, an instrument so sensitive that it can be used to measure incredibly small forces. It is safe to say that, until the advent of modern electric and electronic circuits, the torsion balance was one of the most refined and useful tools in the possession of experimental physicists. To understand the working principles of the torsion balance Coulomb had to know how the suspension wire responded to twisting moments. The equation that gives the relationship between the twisting moment, the geometry of the twisted bar, and its physical properties is known as Coulomb's Law of Torsion. In the course of this study Coulomb became one of the founders of vibration theory, since he arrived at the twisting properties of his suspension by observing the free rotational oscillations of the suspended torsion bar.

Perhaps the most curious of all these works is Coulomb's paper entitled, "Research on the Forces Exerted by Men in a Day's Work in Various Employments." In this country and in these times, we are apt to forget that men and animals provided most of the primary energy available in the pre-steam-engine ages. Coulomb measured the amount of work men could do in carrying bricks in a hod up ladders and ramps; how much

they could do on treadmills and in pushing capstans. He also correlated the amount of food absorbed with the amount of work produced. He found that men were capable of producing on the average, in an eight-hour day, about $^1/_{12}$ to $^1/_{10}$ of Watt's horsepower.

Like Smeaton, Coulomb studied windmills and wrote a paper entitled, "Theoretical and Experimental Observations on the Power of Windmills and the Effect of the Shape of the Sails." Curiously enough, neither Smeaton nor Coulomb was able to improve much on the best windmill designs of the day. Two thousand years of practice had solved the problem without the help of explicitly stated theory.

Finally, and for good measure, Coulomb wrote a paper on "Maximum and Minimum Problems in Architecture," a treatise which deals with arches and walls.

Clearly, if Smeaton is to be number one on our hypothetical list of "retroactive" members of the Applied Mechanics Division, Coulomb should certainly be number two. Perhaps we should elect them both Honorary Members, First Class, with no invidious distinction.

### RANKINE, AUTHOR OF THE FIRST APPLIED MECHANICS TEXTBOOK

Our tale is becoming too long, and I will bring it to a close with a few remarks on William John Macquorn Rankine, late Regius Professor of Civil Engineering and Mechanics in the University of Glasgow.

Rankine was born and bred an engineer, but his work in developing the science of thermodynamics gives him high standing as a physicist in England. All engineers who work with steam know the Rankine Cycle. Vitruvius would have approved of Rankine, since Rankine was "somewhat of a musician." He was more than that; he was a poet, composer of music, competent piano player, and excellent vocalist. His social gifts made him the perfect master of ceremonies at all the technical and scientific meetings of the British Association for the Advancement of Science. We sorely need a Rankine today in the Applied Mechanics Division. At the meeting of the British Association held in Bath in 1864, he used all his social gifts simultaneously in the sturdy defence of the "Three-foot Rule."

> Some talk of millimeters, and some of kilograms,
> And some of deciliters, to measure beer and drams.
> But I'm a British Workman, too old to go to school,
> So by pounds I'll eat, and by quarts I'll drink, and
> I'll work by my three-foot rule.

This tendency to come to the defence of desperate causes was shown even in Rankine's first paper. At the age of 22 he wrote "An Experimental Inquiry Into the Advantage of Cylindrical Wheels on Railways." Before your imagination runs wild let me state that this was merely an early paper in the battle which is still raging between the proponents of conical treads and straight cylindrical treads on railway wheels.

Rankine was one of the first to write on stress concentration, on fatigue; and he was one of the earliest to use the concept of stress. He was an indefatigable writer of engineering textbooks.

In 1858, Rankine published the first of that long line of books in the English language to carry the title "Applied Mechanics." After 2200 years of struggle, starting with Aristotle in Athens, the theory of mechanics had jelled and hardened to the point where it could be "laid out and embalmed" in a textbook to be used by budding engineers. This book went through a dozen or more editions. It has been used in some schools up to recent times. It is still up to date.

The merits and priorities of the contents of Rankine's famous text may be discussed by anyone who chooses to do so. I merely wish to call to your attention one of the best first ten pages of word wangling that ever appeared in any textbook in the English language. When Rankine was appointed Professor of Civil Engineering at the University of Glasgow in 1855, he had to make an inaugural address (in Latin) to the graybeards who were already on the faculty. His speech was entitled "De Concordia inter Scientiarum Machinalium Contemplationem et Usum." This speech, translated into English, with the title "Harmony of Theory and Practice in Mechanics," has appeared at the beginning of every edition of Rankine's "Applied Mechanics." I do not intend to spoil your pleasure in reading these classic ten pages by divulging any of their contents now. Suffice it to say that Rankine was irked by the invidious comparison frequently made between theory and practice. To the Greek thinkers theory was good and practice was bad. To modern men practice seems good and theory seems bad. Today we would compress Rankine's little essay into one dry sentence: "Theory is the distilled essence of practice."

As you read Rankine's measured phrases, consider them as the "dessert" to fare which I have put before you this evening and as a delayed closing of my talk on Applied Mechanics.

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## Competing With Nature's Hand

*(Continued from page 722)*

is the final step in producing the complete glove shown in Fig. 12.

Individual shades and color patterns are duplicated by painting the assembled hand shell. The paint is smeared on very irregularly and shows through the glove, producing a color depth of a shade and a pattern suitable to the individual being fitted. Difficulty has been experienced in obtaining a fast-drying paint that will not be affected by the plasticizer in the PVCA. With all enamels and lacquers used to date, an objectionable orange discoloration of the glove results from migration of the pigment to the polyvinyl. However, it seems that a pigmented solution of nylon in furfural and alcohol will be satisfactory. A few minutes after painting, the glove may be drawn on with the help of a little vaseline. Fig. 13 shows the complete hand ready for use.

### RESULTS ACHIEVED

The hand is still in the experimental stage, and further development is being directed to improving the finger shape to provide a better gripping action and to insure stable three-point prehension, especially for small objects. A manually operated two-position thumb is also under consideration to provide greater opening. In the first model produced, the fingers moved as a unit as previously described. Early service tests indicated the desirability of having the third and fourth fingers made flexible so as not to interfere in any gripping action, and subsequent models are being developed with these fingers and the portion of the hand attached thereto molded from flexible expanded PVCA. The cushioning effect also prevents objectionable noise when the hand is placed on the table. These modifications will cause little change from the present weight of about 11 oz, comprising 3 oz for the mechanism and adapter, 5 oz for the hand structure, and 3 oz for the cosmetic glove.

From the limited service tests so far conducted it seems that this type of hand, a functional device with a natural appearance, would be very acceptable to the amputee and, as soon as experimental difficulties have been overcome, every effort will be made to provide all war amputees with similar prostheses.

# *The* ENGINEER *and His* COMMUNITY

By C. J. MACKENZIE

PRESIDENT, NATIONAL RESEARCH COUNCIL, OTTAWA, ONT., CANADA

I AM deeply sensible of the honor you pay me today. It is a compliment for a Canadian to be invited to address your distinguished society on any occasion; and when the meeting is in Canada and the occasion "The Roy Wright Memorial Lecture" the honor is indeed enhanced. First, I would like to take advantage of this opportunity to join in the messages of welcome you have already received: messages which carry our warm and genuine greetings to a group whom we are delighted to welcome as personal friends and as visitors from the most friendly of neighbors.

I never had the pleasure of knowing Dr. Roy V. Wright personally but I do know something of what he accomplished and, of greater importance, what kind of man he was, what he stood for, and with what affection and regard he was held in this society; and I consider it a great privilege this afternoon to commemorate with you, the name of one of your most loved and respected presidents.

In setting up a memorial lecture to Roy Wright you have paid public tribute to his influence and the high esteem in which you held him as an engineer, as a citizen, and as a devoted public servant. It is, however, from the private comments of his many friends that a stranger gets the truest impression of the competent and likeable man who had that generosity and friendliness for his fellows which endeared him to all with whom he came in contact, and made him the great man he was. One can't help feeling at this time, in a world torn by conflict, confusion, and often by downright malice and bad faith, what a different and pleasant place it could be if the atmosphere of kindliness and devotion to the public good which characterized Roy Wright, could only pervade all peoples in all countries.

### WHAT WRIGHT LECTURE SYMBOLIZES

I am mindful of the purpose the Council had in setting up this memorial lectureship. As officially stated it was "to impress on engineers and young people the duties, responsibilities, and privileges of citizenship in our democracy."

Previous lecturers have dealt with citizenship in the local, state, and federal arenas of the United States; and while one who is not a citizen of your country has no right to preach to you of your local and national responsibilities, we Canadians can heartily subscribe to the practices and principles which guided Roy Wright in his writings and in his day-to-day life. For no one can deny that, in attempting to understand how government and social organizations work, no better start can be made than by direct personal service on local councils, boards, and social welfare organizations. This is particularly good advice for engineers, whose training, although it makes them potentially effective, is not likely alone to give complete understanding of the subleties of political and social activities.

It is not uncommon to observe men who, having achieved marked success and reputation in a specialized professional business or industrial field, assume that their opinions are of equal validity in public affairs. This is one of the weaknesses of our present-day democracies. As Rebecca West so well puts it, "The study of physics or chemistry is no more likely than the study of harmony or counterpoint to develop social omniscience," and she warns against assuming "that the man who possesses a special gift will possess also a universal wisdom."

It is discouraging to hear—as one does occasionally—engineers and scientists with little experience or background in political affairs suggest that a certain baffling social problem could be solved quite simply if it were only left to engineers who, presumably by applying the laws of physical science, would readily find a workable solution. I agree that when engineers add to their professional competence the knowledge and wisdom gained by active participation in citizenship, then they are likely to contribute more usefully than most. But we, as engineers, should never make the rather stupid error of assuming that human actions follow valid and consistent laws such as we have in our fields of physical science. As Sir Josiah Stamp, a great economist and experienced statesman, so well said, "In physical science a force such as gravity will always act in the same way on any piece of matter but in the field of human relations if a man *thinks* a dog is a wolf he will act as if it *were* a wolf."

Because Roy Wright added to his engineering knowledge serious study of public affairs and actual participation in them, he became the great citizen he was. I venture the guess that he never confused his engineering skills and his social and political philosophy.

### A BROAD VIEW OF CITIZENSHIP

As I have suggested, it would not be appropriate for me, a Canadian, to talk as previous lecturers have, of your local institutions and problems. I think, however, it would be appropriate for me to talk today about citizenship in its broadest sense, as today our concept of community and national interest is a rapidly expanding one; and it is becoming realistically obvious to all of us that to the obligation of citizenship in national fields must be added new responsibilities in the field of international affairs, responsibilities which are inherent in our determination to maintain the kind of world we wish to live in.

That Roy Wright also had this conception of a larger community interest is borne out by the words he wrote in 1938. Referring to the vital need for compromise in group activities, he observed: "This is all the more important in these intense modern days when . . . we are all so dependent one upon another . . . This is true not only of our people as a nation, but to a very great extent internationally also, since improved communications, rapid transportation, and world-wide commercial relationships have drawn us all more closely together and to a surprising extent have made us internationally mutually interdependent . . . We cannot escape the fact, whether we will or not, that we are an integral part of the peoples who inhabit this planet and that our fortunes and future are inseparable from theirs." This fact is now more generally accepted than in 1938 when it was penned by Wright—it does illustrate his wisdom and foresight.

Today I would like to emphasize two associated points—I do not claim they are novel, I only suggest they need emphasis at this time. The first, which I think cannot be questioned, is that all effective human co-operation must be based on understanding; not necessarily mutual acceptance of each other's

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views and beliefs, but understanding, based on knowledge of differences, which makes compromise possible.

The second, and most supremely important point to realize, is that it is comparatively easy to be friends but exceedingly difficult to operate as effective and contented allies; and it is as partners in an alliance of freedom-loving nations that we must work and fight if we are to survive collectively in the form we have chosen. The truth of this is obvious. The difficulties do not come in the days of friendship and courtship but when the marriage partnership demands constant adjustments and sacrifice by both parties. We all know that in business, in associations, in politics, whenever we come together for group action, frictions arise, incompatibilities appear, differences of interest are aggravated, a hundred-and-one adjustments are needed that are not required in ordinary friendly social or business intercourse. As Roy Wright put it: "In the last analysis the real objective and problem in a democracy is to live together as a large reasonably contented family, all working together for the common welfare. Human nature being what it is, this is no simple or easy task . . . compromises must be made."

### ALLIES MUST LEARN TO CO-OPERATE

We have learned to work by compromise in local societies, in national groups, and political parties, but it would be naiveté indeed to suggest there are no internal difficulties. What is even more naivé, I think, is to be surprised when difficulties arise between allies with different national backgrounds. In 1951 we are in a world in which we must operate as allies, and it is imperative that we all realize fully it is not an easy thing to do (I fancy military and political leaders of all past alliances have been fully aware of this), but if we are to obtain our supreme goal, permanent world peace, it is of vital importance that we learn the techniques of international co-operation just as Roy Wright and his disciples mastered the realistic techniques of national citizenship.

Probably no other two peoples in the world know more about each other than do we, the United States and Canada; and yet, friendly as we are, and easy as our common language and customs make understanding, we should never assume that our knowledge of each other's circumstances is complete. And because I think such understanding is of paramount importance in the kind of world we now live in I am going to say a few words about my country. I realize of course that much of what I say will be familiar to many of you, but it is normal for the citizen of a small community to know more about a larger community than does the big-town citizen about the smaller place. That is my excuse for the remarks I am about to make.

Canada in 1951 is very different from the Canada that entered World War II, and bears almost no resemblance to the Canada that went into World War I in August, 1914. In 1914 our population was under eight millions—25 years later in 1939 it was eleven millions, and today it is over fourteen millions. These figures alone tell very little, although they do indicate that in the last ten years our growth has been about the same in numbers as in the previous quarter century. In percentage it has been double that of the preceding decade, and twice that of the United States between 1940–1950.

It is the change in character, however, that is significant. In 1914 this country was essentially a producer of primary products—predominantly rural in character. In World War I we provided and maintained through four years of bloody fighting and terrific casualties a corps of infantry soldiers with its complement of artillery, engineers, and other arms. We were essentially front-line soldiers; we had few special units, although a large proportion of the pilots in British Royal Flying Corps were Canadian boys. On the civilian side we supplied shells and ammunition in large quantities, but our great contribution was in foodstuffs and our production capacity in wheat alone doubled in a few years. We went into World War I automatically when Britain declared war, willingly and with great enthusiasm, but virtually as a colony; we came out spiritually an independent nation, bound together by our fierce pride in the battle achievements of the Canadian Corps in which practically every man in Canada of military age and fitness served.

We went into World War II an autonomous unit in the British Commonwealth of Nations. We did not become involved automatically with Britain as in 1914. Our Parliament declared war not when Britain did, but several days later, and of our own volition, but I might say with the same conviction that, in a war for justice and freedom, we wanted to be fighting as we always had side by side with our Commonwealth cousins.

### WORLD WAR II CHANGED CANADIAN ECONOMY

World War II changed our economy completely. More than one million men enlisted in our three fighting services. We put an Army group in the field. On a per capita basis Canada provided more flying personnel than any other nation. On the seas Canadian sailors manned a navy of 780 ships. At the same time our industrial output increased phenomenally in size and character. Before the end of hostilities we were producing most of the intricate weapons of war except battleships, proximity fuses, and atomic bombs. When Canada entered the war in 1939 most of its large industries were branch factories of United States and United Kingdom corporations, most of its industrial research was imported, and no military research and development existed. We emerged in 1945 with strong scientific-research organizations, the only atomic-energy pile outside of the United States, and a strong integrated industry capable of producing almost any kind of intricate industrial goods.

As you know, since the end of the war our industrial capacity has further increased, our national income is three times what it was in 1939, and in every way our industrial potential is today far greater than at any time in history.

Such were our circumstances in the postwar years that instead of receiving financial aid from your nation which gave so generously to others in difficulties, we were in the fortunate position of being able to follow your inspired Marshall plan and grant to other countries credits comparable to our size and resources.

Recently our hinterland has disclosed immense iron deposits in Quebec and Labrador, uranium in western Canada, and titanium in Quebec. The newly discovered oil formations in Alberta give promise of completely revolutionizing the oil position on this continent, and the end is not in sight.

I am not suggesting that this body of engineers is entirely unaware of what has been happening and I would be very much surprised if some of the billions of dollars of United States capital that has poured into Canada in recent years has not come with the knowledge and advice of many of your members. I do feel, however, that many people in Canada and the United States are not fully aware of what a remarkable change has been taking place during the past decade in the fundamental economy of Canada.

But these are material facts which present no difficulties in interpretation. All we have to do as responsible world citizens is to learn about physical developments in other parts of the world. There is no problem of misunderstanding such facts.

As understanding is the basis of effective co-operation, it is important that we as world citizens have knowledge of the differences in social and political institutions in neighboring countries. I am sure that many of the day-by-day manifestations of political action in other countries seem incomprehen-

sible and even downright perverse because we do not appreciate the fundamental differences in governmental institutions.

For instance, take our two countries. No two independent countries have more similar institutions and traditions than have we. We speak the same language, sing the same songs, read the same magazines, and have more personal and business contacts than any other two countries in the world; yet I am certain that some of your political methods seem unusual to many Canadians because in our apparently similar democratic governments there are fundamental differences that inevitably make for different public approaches. I am equally sure you find some of our political policies and tactics equally incomprehensible for the same reasons.

### POLITCAL DIFFERENCES BETWEEN CANADA AND U. S.

The fundamental political difference between our two countries is not that you live in a republic and we in a constitutional monarchy, for we enjoy as much freedom as you. One of the fundamental differences is that our executive is headed by elected representatives who sit in parliament as ministers in charge of departments of government. Such ministers can be retired almost instantly and so can the entire Government, Prime Minister, and all his Cabinet, if at any time the Government loses the confidence of the House of Commons.

The minister in charge of a Canadian department is responsible for all acts of his department and is held absolutely to account. He and he only is attacked in Parliament if anything goes wrong. A public servant is rarely if ever attacked in public, as he has no way of defending himself and, by the same token, no nonelected public official is supposed to speak publicly about policy matters; and any breach is looked upon as a most serious offence. This system means that Canadian officials are rarely associated in the public mind with political controversy and can and do serve a succession of ministers of different political faith with no embarrassment whatsoever. Your system is different, but let me emphasize again I am not passing judgment as to which is better—that is completely contrary to my thesis, which is that it is understanding, not appraisal, that is needed. In your system the executive heads of your great departments of government are not elected representatives and cannot explain or defend their actions as members of congress. This leads inevitably to a situation in which nonelected public officials have to talk about, explain, and even advocate matters of policy and in turn are naturally criticized and become personally associated with the policies of the head of your Government. I mention this one difference which to the casual citizen may not seem important but which does lead to misunderstandings. Many of your people cannot understand why some of our tactical manoeuvring is necessary to get to certain ends, and I am afraid a great many Canadians in turn don't understand some of the activities of your appointed officials because they don't really comprehend the fundamental differences in our political systems; the pressing need is for understanding, not evaluation, of the political institutions of our friends and allies. When we achieve that we shall be able to co-operate internationally just as national groups do regardless of differences in belief, ceremony, and procedures.

Let me mention another example of hidden differences in apparently similar systems. In comparing institutions in different countries we must never overlook the size factor. In engineering, industry, and business we all realize that the type of organization and the procedures effective in small organizations will be quite inadequate for large units, and so in reverse it would be absurd and wasteful to surround small operations with all the complicated controls necessary in large operations. In the same way it is unwise and misleading to make a direct comparison between the types of organizations found in small countries and those of larger ones. It is often even more misleading to compare results or activities on a basis of costs or relative numbers of personnel. Let me mention one field with which I am familiar. In our government scientific organizations I believe we are able to get, speaking in over-all terms, more scientific work out of each research scientist than you do in your large government institutions. The reason is that we, being relatively small, have few large headquarters formations and committee structures, which in a large country seem to absorb an unfortunately large percentage of the available manpower-hours. While we are sure that as a whole the output of our scientists on a per capita basis is greater than yours, we do not jump to the erroneous conclusion that we are better at organizing scientific effort or that our scientists are better. We shall have to wait until we are as large as you are before that question can be answered. So when we compare the scientific effort of different nations in terms of relative population we may deceive ourselves if we use the simple yardsticks of dollars spent or numbers of scientists employed per million of population.

### CANADA'S CONTRIBUTION TO DEFENSE

Another field where direct comparisons are difficult is in defence. Canada could never go to war on its own. We always have and always will be operating with allies of greater size, whose forces are complete and all encompassing. This makes our contribution to a common war assume a distinctive form. For instance we have an area within our borders larger than yours and just as vulnerable to attack, but we have only $^1/_{12}$ of your population and $^1/_{18}$ of your national revenue. If every able-bodied Canadian of military age were in our forces, we probably would not have enough to man adequate static defences for our principal cities and ports. In peacetime, therefore, we must concentrate on mobile forces, air-borne troops, fighter aircraft, and naval vessels. In a general way, in war our contribution must follow a similar pattern and supplement the forces of our allies. In the air we are now concentrating on fighters and troop transports; in our navy we concentrate on escort duty which has been our traditional role. On the civilian front our industrial strength and resources far outbalance our military strength. During World War II 70 per cent of our production was in excess of our own needs and today, in spite of our relatively small population, we are among the first half-dozen industrial nations in the world. All of this means that, because of this natural lack of balance, our contributions to any alliance cannot be ascertained by a direct comparison of troops on supplies on any exact basis of population or national wealth.

I could go on giving example after example, and if we extend our study to other countries, the areas that need our serious study multiply greatly. But I think I have said enough—perhaps too much. I fear that I have taken your invitation too literally, as I seem to be lecturing to an audience which does not need it; but my excuse is that these lectures are supposed to reach ultimately a larger and younger audience.

In bringing my remarks to a conclusion may I repeat that I as a Canadian am deeply moved by being asked to give an address in memory of one of your most loved Presidents. I am aware of the personal honor but I like also to think of my invitation as a measure of the warm friendship and respect that exists not only between our respective professional societies but between our two peoples.

I have taken the liberty of interpreting citizenship and community responsibility in a broader way than former Roy Wright lecturers have done, but I do feel sincerely that if we are to win this global struggle for democratic freedom to which we are dedicated, it is absolutely essential that we expand our concep-

*(Continued on page 734)*

# STORAGE *and* HANDLING *of* PULVERIZED MATERIALS

By FRANCIS SILVER

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## GENERAL STORAGE PROBLEMS

ENGINEERS, in general, in their college courses, receive excellent training in the flow of perfect fluids. They are able to solve adequately most problems of perfect-fluid flow which they encounter in practice.

Imperfect fluids, however, are another story. Engineers receive little or no training in school, concerning the laws for imperfect fluids. In practice, when they encounter problems with imperfect fluids, they most often attempt to use the perfect-fluid laws they know. The result is seldom successful.

Bins and chutes with great dents beaten in them and poke holes cut in them by frantic operators trying to get the material out, thickeners that are operated at considerably less than optimum pulp density, because the sludge starts building up on their improperly designed rakes, thin metal farm silos whose sides have crumpled, feeders that do not feed uniformly, are the rule rather than the exception.

We can only regard these conditions as engineering failures. We have been attacking these problems with methods that are not valid, and our solutions have low predictability. If bridge builders used methods of no greater predictability, we could expect most of their bridges to collapse the first year. If an engineer designs a bin-and-chute system for a certain material, and the material does not flow out freely without a lot of help from the operating personnel, then it constitutes an engineering failure as surely as when a bridge collapses. The failure usually does not endanger human life and hence is not as widely publicized. However, it is still a failure.

As professional people we should make serious efforts to correct this condition by modifying college courses and by educating the engineer already practicing, through the technical journals.

## APPROACH TO FLOW PROBLEMS

There are many ways to develop a more fruitful approach to flow problems. The angle-of-repose concept for granular materials in chutes and bins is old and familiar to most engineers. Unfortunately, this intellectual tool is not adequate. Another helpful approach is the study of many special cases. This method is being used extensively at present. The literature on imperfect fluids in special flow situations is multiplying rapidly.

As with the hydraulics situation before Reynolds number, when empirical equations for special material under special conditions were available in great quantity, they worked well with an identical condition. Usually, the situation was different, however, and then there was not even information for a good healthy engineering guess. The more general approach of Reynolds number filled in the gaps for perfect fluids. Now we must take the next logical step and formulate a more general theory of flow to include imperfect fluids, plastic flow, soil mechanics, rheology, and so forth. A small part of the effort now being devoted to studies of special cases could give us a working general theory.

Perfect fluids should be regarded as a special case of this more general theory. Engineers must stop discussing "flow of perfect fluids" as just "flow of fluids" without qualifying it. Rheologists have done so for some time. Even if we never formulate a one-equation treatment for all conditions of flow of perfect and imperfect fluids, the general approach will be rewarding. At present the most serious errors from the lack of a theory of flow for imperfect fluids arise in the no-flow (static), slow-flow region, and it is this area that will be treated primarily in this paper. Differences in flow characteristics between perfect and imperfect fluids are very much less, possibly negligible, in the turbulent-flow region.

## STRUCTURAL PROPERTIES OF IMPERFECT FLUIDS

Investigations of the structural properties of imperfect fluids have been hampered by their seeming erratic behavior. Quite often erratic behavior is found to be caused by a variable left out. Here is no exception. With gels and colloids, erratic behavior was usually explained away by saying the materials were thixotropic, and until very recently, little attempt was made to determine quantitatively what happened to flow properties during a thixotropic change. The erratic behavior of other materials of coarser and drier structure, such as grain, coal, dusts, meals, and the like, were not dignified with a label like thixotropy, although operating personnel, both engineer and lay, have vied with one another to describe most colorfully, if not quantitatively, their behavior.

In this paper the term thixotropy will apply to any imperfect fluid that increases its yield point with time. In addition to using it to describe certain fine-structured gels or colloids, the term can be very useful with coarser materials such as dusts, grains, and even rocks as big as coconuts, or bigger, stored in mass, if they get stuck together by silt, glue, through natural cementing properties like slag, or by fusion from heat. These different types of flow can be shown graphically in several ways. One of the simplest follows.

The thixotropic curve in Fig. 1 is a supposition. Its form should be determined accurately by someone with access to a Brookfield or a modified (1)[1] Stormer viscosimeter, or perhaps other instruments will have to be devised to measure it. Green and others (2, 3) have measured thixotropy at higher flow rates for certain types of materials and have made some mathematical analyses of them. They have not covered the no-flow, slow-flow region of most importance to engineers. The thixotropic effect on the yield point has been dismissed by saying that the drop from the static to the dynamic yield value takes place almost instantaneously. We must modify present apparatus, or devise new, so we can quantify static yield points accurately and determine what happens as flow begins.

There is some argument over just what phenomena are to be

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[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

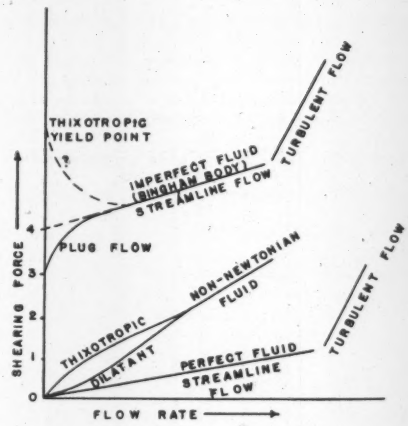


FIG. 1 FLOW CURVES

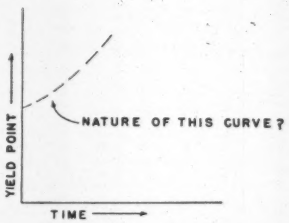


FIG. 2 THIXOTROPIC YIELD-POINT CURVE

covered by the term thixotropy that probably can be clarified only by getting more accurate information on the effect of thixotropy on static yield points and on the transition to dynamic yield point as flow begins. When we have this information, if a new term seems necessary, then we can coin one.

The starting point (yield point) of the thixotropic flow curve on the Y-axis will vary with time. The nature of this change for various materials can be plotted as in Fig. 2.

Other variables than time may be plotted as families of curves as in Fig. 3.

The viscosimeters previously mentioned can be used for determining these characteristics. These should be determined for representative materials and placed in tables in engineering handbooks.

In dealing with materials as large as grain, it is easy to visualize the thixotropic change as one involving a changing coefficient of friction between the granules (Fig. 4).

With a little more difficulty this same concept can be used to visualize the increase in yield point in dusts or powders as the fluidizing air film leaves, or in colloids as gel bonds become established.

There is a great deal of information available on the streamline and turbulent-flow regions of perfect fluids. The practicing engineer is generally familiar with and makes use of this. The streamline and turbulent-flow regions of imperfect fluids follow the rules for perfect fluids closely enough to permit them to be treated similarly. However, streamline flow and turbulent flow are not sufficient to deal with imperfect fluids.

Another type of flow, plug flow, must be considered. The shearing force on a liquid, flowing through a pipe, increases toward the wall and approaches zero in the center in the streamline-flow region. Near the center, where the shear is less than the yield value, there will be no relative motion between particles, and the center will flow together as a solid plug

The plug-flow region has been treated mathematically from first principles by Bingham, and the equation verified experimentally in considerable detail by Caldwell and Babbitt (1). The 4/3 relationship between the yield point, and streamline-flow region, projected as a straight line until it strikes the Y-axis, is demonstrated both mathematically and experimentally in their paper. When the yield point becomes zero, the Bingham equation fits perfect fluids in the streamline region, so a general theory in the streamline region is nearly complete except for thixotropy.

Caldwell and Babbitt also derive equations for the critical velocity (change from streamline to turbulent flow) and for turbulent flow. These equations they check experimentally. In turbulent flow, using the density of the sludge and the viscosity of the sludge-dispersion medium in the equations for perfect fluids, seems to hold quite well.

The term "dilatancy" is sometimes applied to fluids whose viscosity increases with flow rate. We should be careful to restrict its use to non-Newtonian fluids. The term should not be used to describe the plug-flow region of fluids with yield points, because the increase in apparent viscosity here is of a different sort. We would then end up with three types of flow in common usage, plug flow, streamline flow, and turbulent flow. The term plug flow is now used occasionally but not generally. The characteristics of plug flow are not as generally understood as the other two types of flow, although throughout industry situations involving plug flow are nearly as prevalent as the other two types.

The remainder of the paper will be devoted to practical problems with specific materials to give concrete illustrations of the need for more precise methods for dealing with static and

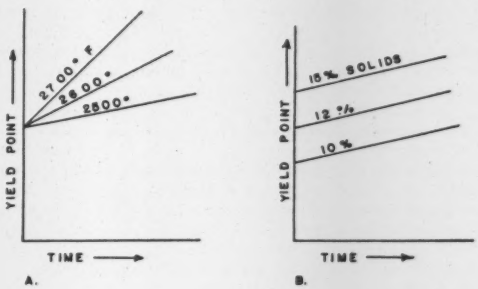


FIG. 3 FAMILIES OF FLOW CURVES

(A, Family of thixotropic yield-point curves at different temperatures, where thixotropy is caused by fusion. A similar system would apply to grains of different per cent moistures. In some situations pressure might affect yield point versus time curves. B, Other parameters may require other families of curves.)

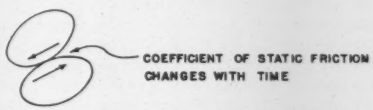


FIG. 4 CHANGING COEFFICIENT OF FRICTION

flow problems involving imperfect fluids, especially thixotropic ones. Techniques that are already available will be reviewed, and needed research will be indicated.

### STATIC AND FLOW PROBLEMS IN GRAIN HANDLING

Flow through a circular orifice with perfect fluids is proportional to the square of the diameter and the square root of the head. For grain the flow is proportional to the cube of the diameter and independent of the head (4, 5). An investigation should be made to determine how this change takes place as fluids become less perfect.

An investigation of buoyancy in imperfect fluids may prove interesting. The Archimedes principle does not hold for wheat. What then are the relationships, and what happens in the transition area between imperfect and perfect fluids? Is there something akin to surface tension on a large scale that operates in imperfect fluids which enables the operator to walk across a bin of wheat, sinking less than up to his knees? On the other hand, is this simply the yield point in operation, functioning in the same way when it prevents an object much denser than the wheat from sinking to the bottom of a bin when the object is immersed in wheat, or an object less dense than wheat from rising to the surface?

In drawing grain from bins, plug flow operates to draw the grain from the top of the bin down a central moving column over the outlet. The top of the bin cones down and feeds into the moving column over the outlet, top layer after top layer. Grain must be "turned" to prevent heating. The flow characteristics make it necessary always to "turn" into an empty bin. If grain flow was like water flow, the grain could be drawn out and put back on top of the same bin. With grain, however, feeding off the top, only the top portion would get stirred this way. The top portion would just circulate around and around, the remainder of the bin would not be affected. This effect can be studied readily in bins as small as a foot square or smaller and only a few feet high, with one glass side. Streaks of different colored dust may be put along the glass side to form flow lines. The plug flow may extend from side to side of the conductor if the flow rate is low, the yield point fairly high, and the outlet not restricted. Lack of mixing in plug flow has been a serious problem in grain driers where mixing is desirable. Unless there is mixing, some grain gets overdried and some not dried enough.

Grain handlers have a problem of taking temperatures of grain to discover heating and of introducing gas into the grain for fumigating. Often operators have built pipe structures in the bins to accomplish this more uniformly, and, in wooden grain bins, tie rods are used to hold the walls together. Most of these structures get torn out of the bin and have to be abandoned. The heavy pressures that loosen the structures probably occur during filling. Broken tie rods get bent until they look like ribbons draped across the unbroken rods. Probably here the bending is done a little each time the bin is filled. An investigation of the nature and magnitude of these stresses should prove interesting.

Pressures in grain bins do not follow the laws for perfect fluids. Instead of: "Pressures are proportional to the height of the column of liquid, and are uniform at a given depth," we have for grain, "static pressures increase proportionately less as the column of grain gets higher until at a height about $2^1/_2$ diameters it stops increasing." The pressure varies depending on whether the bin is being filled or emptied, how long the grain has been sitting, grain condition, and, if emptying, where the opening is, as pressures 2 to 4 times normal may occur with an opening at the side when the grain is being drawn out. The higher pressures are on the side opposite the opening. The graph of an experiment, given in Fig. 5, well illustrates this point.[2]

The horizontal lines showing decreasing pressure with standing indicate quantitatively one effect of thixotropy. Note that grain pressures, although usually less than perfect fluid pressures, can be greater under certain conditions.

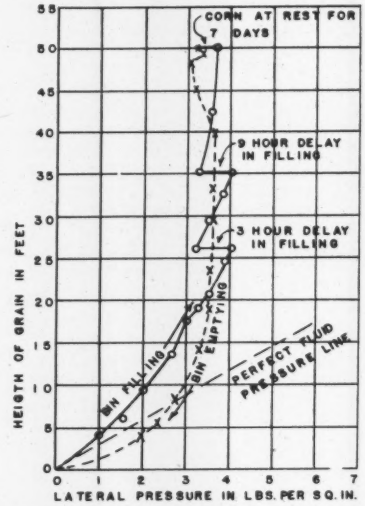


FIG. 5 LUFT'S EXPERIMENT ON CORN BIN FILLING AND EMPTYING (Corn 48.4 lb per cu ft; smooth concrete bin 23 ft 10 in. diam.)

In deep grain bins most of the weight is not carried on the bottom of the bin as with perfect fluids, but is carried out to the sides of the bin by a dome effect. Bins designed for perfect fluids may fail by crumpling of the sides, or by the sides being forced into the ground if grain is put into them. Bins that hold grain quite well may burst if perfect fluids are put in them.

If grains are stored without turning, especially if the moisture, temperature, infestation, and dirt are high, they will stick together. In mild cases of this sticking, when emptying the bin, great soft cliffs will be left that will gradually break down into large chunks that usually crush themselves in going out the opening, although sometimes they may block the opening. At other times a kind of erosion takes place with deep channels cut in the cliffs. Where the grain is not turned for a long time, progressive heating, sticking, and deterioration take place, finally resulting in a charred mass that must be dug out with picks.

### PROBLEMS IN GETTING A GRANULAR SOLID OUT OF A BIN

The author was recently told a sad story by an engineering salesman for a salt company. A feed company in Baltimore with a newly erected "working house"[3] feed-mixing plant had bought several carloads of fine salt and had put it into one of the bins to run out over automatic scales into the feed-mixing line. After about 20 tons of salt had run out, the rest hung up in the bin so tightly that air hammers were required to break the salt out of the bin.

[2] Reference (4), p. 344.
[3] Ibid., p. 297.

The plant is near the water front and the air is quite damp. Underneath each of about 20 bins are the latest in automatic proportioning feeders emptying onto a belt to mixers and baggers. The automatic feeders are so arranged that if the feed goes off any machine, the whole apparatus stops automatically. Not long ago the author was at this plant for about 2 hr, during which period the equipment was stopped three fourths of the time because of some ingredient hanging up in the bin, usually one of the meals—soybean or ground corn. The operator would poke up through a porthole with a rod to dislodge the material and then start the machinery and run till the feed stalled again.

On top of the bins was an improvised winch which was used in lowering men down onto the top of the material to try to dislodge it. The author was told that often the material would feed out in a tall flue as much as 60 ft high and about 1 ft square. As many as six or eight men jumping up and down on top of the material would try to dislodge it when it hung up.

As in many plants there were no ladders inside of the bin since they are hard to cast in place using slip forms. Hence the designers excuse themselves by saying in their handbooks, that "ladders shouldn't be put in bins because it is dangerous to be in them, considering the lack of good air and the danger of being buried." As a result the unfortunate operators are forced to use improvised methods of access into the bins, for believe it or not, men are still going into bins even in the latest plants where no ladders are installed.

The same sort of thing was discovered at a new feed-mixing plant. No ladders were installed. The material will not flow out, so the operators lower each other down into the bins on ropes to try to work out the material.

In another instance, the operator lined the bottom of the bin with screw conveyers. And so the stories and experiences run.

Dry coal will feed out all right but wet coal hangs up. Coarse coal feeds out all right but fine coal hangs up. Nearly everywhere one goes he will see weary-eyed men beating and poking at bins and chutes. When they find out that the visitor is an engineer they want to know "what is wrong, why doesn't the material come out?"

We need a comprehensive theoretical and practical study of material flow from bins and down chutes under a wide range of conditions. Not just timid little suggestions about angle of repose, and the like. Some suggestions along these lines have been made which should be reviewed. Hudson (6) discusses this problem at some length. He speaks of having considerable success with thin suspended sheets of stainless steel in a hopper. Before devices of this nature can be employed intelligently, a study must be made of the magnitude of the forces which ordinarily strip such things out of a bin. Certainly these forces are very great, and should be understood thoroughly before employing devices suspended in the bin.

One company is now advertising a new unit for introducing air into a bin through a square of canvas to facilitate flow of material. The suggested arrangement is to place the units in lines from the break in the bin all the way down and out the chute. The number of units to be used depends on the type material, bin design, how completely it is to be emptied, and so forth. The advertising matter does not suggest that the air must be dried carefully, or caking may be aggravated, depending on the material.

Vibrators have some value but must be used properly, as they may compact the material rather than fluidize it. The applications for vibrators should be determined accurately. There are several types on the market for unloading hopper cars; some hang on the sides and vibrate magnetically, some straddle across the top and use a motor-driven eccentric to produce the vibration. Their effect on the tipple on which the car is resting is not mentioned but should be investigated, as it is likely to be significant.

Some companies specializing in bin erection have arrived at empirical relations which facilitate flow from a bin. This information should be collected and published, together with the other laws for flow of imperfect fluids. In a recent conversation with a sales engineer of one such company, some of these relations were pointed out. Openings should be long rather than round or square. Presumably this gives only the single-arch instead of the double-arch effect. Openings for difficult materials should be in the side of the bin instead of the bottom. This is strongly emphasized. Probably the dome effect that transfers the weight of the stored material to the sides acts downwardly to crush the arch or the sides of the material of the side opening. However, there may be another explanation. In any event, this phenomenon should be analyzed mathematically and experimentally. The company's experience with spiral chutes inside the bins to prevent coal breakage had been such that they strongly advised against it, as it usually strips the chute out of the bin.

### OTHER CONSIDERATIONS

*Dusts.* Dusts change rapidly from the very fluid aerated dust where each particle is surrounded by an air film to a material having entirely different flow characteristics as the air film leaves (7). In dealing with dusts one should have a grasp of the complete range of flow characteristics, and the time and conditions to effect this change. Means of dealing with the various types of flow must be incorporated in any design.

Some fairly satisfactory arrangements that keep the dust aerated are available on the market. Some, such as small ingredient feeders in flour mills mechanically agitate the powders. Others, like the airslide conveyer, force compressed air through a canvas-chute bottom. The dusts thus aerated flow almost like water.

*Thickeners.* Many thickeners for strongly thixotropic materials with high yield points have been designed as if they were handling only perfect fluids, or simple granular materials. The designer is in too great a hurry to get the material in near the center and installs blades with such a high angle of attack that the material turns with the rake instead of being moved toward the center. Designs should be developed using more rake arms, with more and smaller blades, and a lower angle of attack. What happens with present designs is that an annular ring forms in the central area; this then builds out until practically the whole sludge mass is turning with the rakes like a huge disk. Additional sludge entering the thickener then settles on top of this disk, until the rakes are overloaded. Most of the apparatus is well designed; just a few critical points are missed through lack of understanding of flow characteristics of imperfect fluids.

*High-Temperature Continuous-Flow Heat Recuperator.* Continuous countercurrent-flow heat exchangers usually operate quite well, but are limited in how high a temperature can be reached efficiently in the gas being heated. The Bureau of Mines has recently attempted to make a new type of high-temperature heat exchanger for its underground gasification of coal project. The process is to use MgO pellets, heating the pellets continuously in one vessel for continuous recovery of their heat. The cooled pellets are then fed back into the top of the first vessel to be reheated.

The problem has not yet been solved in an entirely satisfactory manner for as high temperatures as desired because of difficulties with pellets sticking and short-circuiting, such as was described in the case of grain flow. The thixotropic concept applied quantitatively to the sticking, whether caused by

high-temperature fusion or by impurities in the gases will be useful. Advances in our understanding of the flow of granular solids will help in handling the pellets from vessel to vessel without short-circuiting.

### CONCLUSIONS

Engineers generally do not deal adequately with imperfect fluids. The following steps should be taken to correct this condition:

1 Formulation of general theory of flow (8) of perfect and imperfect fluids by adding time as an additional parameter for thixotropic materials.

2 Extension of the term thixotropy to include any material whose yield point increases with time for any reason whatever.

3 More emphasis on quantifying thixotropic changes in yield point and flow characteristics of imperfect fluids especially at very low flow rates, and this information made available in engineering handbooks.

4 Restriction of the term dilatancy for flow rate to non-Newtonian fluids (fluids whose viscosity is nonlinear with flow rate but do not have a yield point) (9, 10).

5 Development of theory relating flow characteristics of a granular material to frictional characteristics between particles.

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## Appendix

For those engineers who are not familiar with the "method of approximation," as a precise method in engineering the following explanation is offered:

One variation of the method is used in astronomical calculations. For instance, to compute the orbit of the earth about the sun by the method of approximation: First approximation—earth moves about the sun in circular path with sun at center; second approximation—earth moves about the sun in elliptical path with sun at one focal point; third approximation—center of gravity of system, earth-moon, moves about the sun in elliptical path with sun at one focal point, which makes earth's path sinusoidal, superimposed on ellipse; fourth approximation—introduce distortion produced by major planet; fifth approximation—introduce distortion in path produced by next major planet, etc., etc., until orbit is calculated accurately enough for the purpose required. This method may be expressed mathematically as $y = f(x_1, x_2, x_3, \ldots x_n)$ in a world that actually functions thus: $y = f(x_1, x_2, x_3 \ldots)$. where $x_1 > x_2$.

As another illustration, the numerical values of trigonometric functions and logarithms are similarly computed, using the first several terms of an infinite series called Taylor's theorem (see any calculus book). Progress in fluid dynamics may continue along the line of closer and closer approximations rather than by the discovery of the "ultimate equation."

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## The Engineer and His Community

*(Continued from page 729)*

tion of community interest and responsibility to cover all people of good will wherever they be found.

I have talked a bit about Canada and our international relations as I think our two countries have given the greatest example of how autonomous people can solve their mutual problems, settle all disputes, and live harmoniously behind borders whose only defences are those of mutual regard and affection. We not only have lived as good neighbors in times of peace but as allies we have fought side by side through two world wars, and in Korea today we are again fighting under a unified command. This is as it should be and as it must remain, no matter what challenges we face.

Our population is relatively small, not more than that of one of your sizable states, but to our alliance we bring, besides numbers, a long and intimate association with British Commonwealth countries, an association which today has few if any binding legal ties but which nevertheless permits us to draw spiritual and material strength from the culture of two great races with their traditions and ideals of justice, freedom, and intellectual and practical effectiveness.

We feel strongly that any alliance of nations in which the United States and the United Kingdom are not the principal parties will have no chance of bringing permanent peace to this world and we feel that, understanding the people of Britain perhaps better than you do, we can play a helpful role and by the same reasons we can, and I think do, assist the other members of the Commonwealth in understanding your great country, as after all we are both North American nations and that means much. I believe we all agree that as North Americans we have great responsibilities today. We have not only inherited high ethical standards and a sense of justice from our common ancestors, but we possess a continent of vast natural resources, which is our good fortune. True we have wrestled with and tamed our resources on the grand scale, but we must be careful not to look with disdain on other peoples who live in lands not so well endowed. I suggest that humility is still a virtue, and when we think of our high standard of life I suggest we do well to give Providence a fair share of the credit.

That nature has favored us with great material wealth makes our responsibility the greater. This I suggest is in keeping with the philosophy which made Roy Wright the great citizen he was and gained for him the greatest of all riches, the warm friendship of a host of people from all walks of life. He understood what public responsibility was. "Noblesse oblige" was to him no meaningless cliché. I respectfully submit that when we accept, as we do today, the idea of a still larger community to which we have a responsibility, we do not offend the spirit of that great man whom we honor this afternoon.

# *BRIEFING THE RECORD*

## Abstracts and Comments Based on Current Periodicals and Events

COMPILED AND EDITED BY J. J. JAKLITSCH, JR.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

## Military Production

AS DIRECTOR of Defense Mobilization, Charles E. Wilson, Mem. ASME, has recently submitted his second quarterly report on the defense mobilization program of the United States. This latest report, "Meeting Defense Goals—A *Must* for Everyone," covers the work of all the participating defense agencies and has been prepared with their collaboration. It reports not only on the defense mobilization of the United States but on the progress of building defense strength throughout the free world.

Of particular interest to mechanical engineers is the section on military production, which, Mr. Wilson states, is still for the most part in the "tooling up" stage.

During the April-June quarter, about $10 billion of orders for military supplies, equipment, and facilities were placed with industry, the report states. This brings to $42 billion the total of orders which have been placed since the Korean invasion or were on the books, undelivered at that time. Of this amount, close to $10 billion has been delivered to date.

During the past quarter, another $5.5 billion was appropriated by the Congress for military procurement and facility expansion. For the fiscal year beginning July 1, the President has requested $49 billion for these purposes, including military aid under the Mutual Security Program. This would bring to $95 billion the total available to the Department of Defense for expenditure for these purposes since Korea. It would permit a rate of obligation throughout the next 12 months averaging from $3.5 to $4 billion per month, or about the same rate which has been maintained during the past 6 months.

But while order-placing and tooling-up still characterize the production effort, deliveries in volume have started on many items and many others will reach this stage during the coming quarter.

Deliveries of end-items and construction activity have now reached a level of $1.5 billion monthly, compared to less than half a billion monthly pre-Korea. By June, 1952, the delivery rate is scheduled to rise to $4 billion a month.

With the large volume of outstanding and new orders and under the schedules established, the load of military production being carried by the American economy will steadily increase for the next 12 months.

### AIRCRAFT AND TANKS EMPHASIZED

The military production program is particularly heavy in aircraft, combat vehicles, and electronic equipment. The program also emphasizes new weapons, such as guided missiles, and items for which long periods of time are required to organize production and to subcontract for component parts. Aircraft and combat vehicles are again prime examples of the latter.

By contrast, "moth-balled" ships can be recommissioned, artillery can be "decocooned," and small arms "uncanned," reducing the need for new production of these items.

In aircraft, deliveries are currently about two thirds higher than a year ago. The average hours worked in the aircraft and parts industry have been increased from 40 to 44 hr over the past year. Present schedules call for tripling the current rate of deliveries in the next 12 months or so, which is a big increase but still somewhat short of targets set by the President when he proclaimed the national emergency. To meet the special problem in this area, an Aircraft Production Board has been established.

The increase in aircraft production will come largely from plants activated during the past year. In preparation for the climb in output, production workers employed in the aircraft and parts industry increased from 185,000 a year ago to more than 300,000 in May, 1951.

During the first weeks after Korea, orders were placed in quantity for tanks and other combat vehicles. The first of the new light tanks came off the production line in March, three months ahead of schedule. Output of the "General Patton" medium tank will increase within the next few months as new facilities not in use at the time of Korea come into production.

In dollar terms, the tank automotive program is considerably smaller than that for aircraft, but the scheduled increases in production are even more spectacular. Deliveries are currently four times what they were a year ago and another

### How to Obtain Further Information on "Briefing the Record" Items

**MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.**

**For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources: i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.**

fourfold increase is scheduled in the coming 12 months. Despite these increases, production is still behind schedule.

The 3.5-in. "super-bazooka," which was just out of the design stage a year ago, has already been furnished in quantity to our forces in Korea and production is meeting our other needs to the point where schedules for the near future are below current rate of production.

### TOOLING-UP BOTTLENECKS

Between the obligation of procurement funds and the beginning of quantity production, there is a period of "make-ready," which may range from a few weeks to more than a year—depending on the character and complexity of the equipment being produced.

A bottleneck at this time is the shortage of engineers, designers, and draftsmen, men who know how to equip and tool plants for manufacturing defense products on a quantity-production basis, the report states. Such skilled manpower is available in industry and needs to be obtained by placing defense contracts and subcontracts in the industries and localities where it exists.

A second bottleneck is the limited output of machine tools and other production equipment.

Many of the nation's 1.7 million machine tools are being diverted to military production. But some are highly specialized for peacetime products while others are obsolete, and few are suited for production of the new types of military weapons, such as jet engines, modern ammunition, and guided missiles.

To make possible production of particularly important machine tools in advance of specific orders by contractors, a revolving fund of $100 million has been authorized in order that the manufacturers may proceed under Government orders. As the machines are produced and delivered to private contractors, the Government orders are canceled.

A factor that has delayed machine-tool production in this emergency has been the problem of adequate pricing to meet present conditions—a difficulty which is being overcome through adjustments in the pricing regulations. With the greatly increased number of machine tools in place at the end of World War II, the industry shrank after the war. The need for increased production after Korea thus required the addition of extra shifts of workers, overtime work, and the utilization of subcontracting on a large scale. All of these added to the unit cost of production and prevented the called-for expansion until prices were adjusted in the light of the new costs.

The shortage of machine tools and other production equipment has also been eased to some extent by the release of such machines from our reserves. After World War II, more than 100,000 major pieces of production equipment were placed in storage. Of these, 35,000 have already been put back in production and others have been allocated for specific plants.

### RESERVE PLANTS

During World War II the Government built 1600 separate plants at a cost of about $12.7 billion, which did not include plant-expansion projects financed by the Government at a cost of about $6 billion.

In the course of disposing of these plants, a total of 440, built at a cost of over $7.5 billion, were retained as a reserve of industrial capacity.

More than half of these reserve plants, 278, are now producing defense items, and another 66 are being reactivated. Included are 17 plants for the production or fabrication of aluminum, 12 for magnesium, 5 for alloy metals, and 1 for copper. The Nicaro nickel plant in Cuba, now being reactivated, has an annual capacity of 30 million lb. The reactivated magnesium plants alone, when all are in production, will provide magnesium at a rate six times the rate of production from all facilities operating in 1950.

Plants have been or are being reactivated for the production of B-47 medium jet bombers, F-84 fighter bombers, and aircraft engines.

The Department of Defense has programmed nearly $6 billion for plant expansion and tooling.

### NEW WEAPONS BEING PRODUCED

The host of new weapons already designed are being tested, and the present tempo will compress the period of time normally required for these designs to reach the production stage, according to Mr. Wilson.

The most striking advances, the report reveals, are in the field of atomic weapons. Atomic bombs, considerably improved over those used in World War II, are being produced on an industrial basis. The development of atomic warheads for artillery shells and guided missiles is proceeding, as is that of the atomic-powered submarine. In addition, progress is being made in defense measures against atomic attacks, in methods of detecting and measuring radiation, and in decontamination procedures.

The Korean campaign has demonstrated the ability of the early General Patton medium tank to outmatch the Russian medium T-34 tank. More important, the models of the medium tank coming off the production line today embody substantial improvement over the first General Pattons. The gun is considerably more powerful and compact, permitting greater ease and rapidity of loading and the carrying of increased quantities of ammunition, and improved fire control has been installed.

A great deal of experimentation and practice has gone into air-borne operations. Tied into this is the continuing effort to lighten every item the soldier carries. For example, the 3.5-in. super-bazooka weighs less than its World War II predecessor, the original 2.36-in. model, although it has twice the power of the old one. A new intrenching tool will replace the shovel, pickmattock, and axe and cut nearly 4 lb from the weight. The new aluminum-nylon helmet will save 8 per cent in weight while affording greater protection. New tropical combat boots will save $^3/_4$ lb and new mess kits will save almost a pound. Progress is being made in the development of lighter rifles, pistols, machine guns, and ammunition.

Some new developments which have greatly expanded the horizons of air-borne operations are airplanes of greater cargo-carrying capacity, especially designed for quick loading and unloading of large and heavy pieces of equipment, new larger parachutes, and cushioning platforms to prevent damage on landing.

The largest transport now in service is the four-engined C-124, with a speed of over 300 mph, a ceiling of over 20,000 ft, and a maximum range of over 4000 miles. It can carry a light tank, or 20 jeeps, or, by converting to a double decker, 222 paratroopers.

All of the present transport planes will be dwarfed by the six-engined XC-99, the transport version of the B-36. This giant plane has a gross weight of 300,000 lb, a maximum range of 8100 miles, and a cargo capacity of 100,000 lb or 400 troops. It should be capable of carrying medium tanks or self-propelled heavy artillery.

New and better bombers and fighters are also in the offing. The first all-weather jet fighter, the F-94, has gone into action in Korea, and the XF-91 is a new high-altitude jet interceptor. The outstanding bomber prospect is the all-jet XB-52 to replace the B-36. It is the first plane in many years to go into production without prior extensive flight tests, but quantity production is still two years away.

The first of a new series of antisubmarine submarines has been launched. Another outstanding development in the Navy is a new compact radial-type Diesel engine to power submarines. This engine is only two thirds the size and one half the weight of the engine formerly used—and savings in space and weight are as vital in submarine operation as in aviation. Another Navy development is a new rocket launcher, to be installed in aircraft, which launches rockets of improved range and underwater performance against submarines. A ship-to-shore cableway has been developed, carrying 30 tons an hour from a ship 500 ft offshore.

#### SCIENTIFIC TALENT MUST BE DISTRIBUTED TO BEST ADVANTAGE

If the United States is to preserve its technical superiority over the Soviet Union, Mr. Wilson's report warns, its scientific manpower resources must be mobilized for defense. This mobilization requires many careful decisions in order to insure that the training and ability of our scientists are used to maximum advantage.

One of the problems which universities face in this connection is diverting enough trained personnel to research projects which serve the defense effort without cutting back too far in teaching and basic research, for it is these activities which insure a continuing flow of trained scientists.

The newly formed Science Advisory Committee is considering this and related problems. The Committee has stressed the importance of preserving the atmosphere of self-determination in the belief that scientific advancements can be achieved best with as little regimentation as possible.

## U. S. Atomic Progress

PRESENT expansion of atomic-energy production facilities just about equals the wartime construction effort of the Manhattan Engineer District, according to a recent statement made by Gordon Dean, chairman of the Atomic Energy Commission, before the New York Chamber of Commerce, and appearing in the *Defense Production Record*.

Most important phase of this construction, it was revealed, is the billion dollar project at Aiken, S. C. The facilities at Paducah, Ky., now under construction—a $500,000 project—compare in size to those at Oak Ridge.

In addition to new construction, both the Hanford and the Oak Ridge plants each are undergoing expansion costing about $200,000.

These plant facilities are the "factories" of atomic-energy production. Directly and indirectly, about 90,000 people are working in the atomic-energy program.

This program takes three principal directions—weapons, atomic power, and radioisotope production.

#### WEAPONS

Of these, weapons production is the largest and most important. Besides the actual production of bombs on an industrial basis, the Commission is working on the development of new atomic weapons—the hydrogen bomb, improved types of atomic bombs, and atomic warheads for artillery and guided missiles.

Increasingly rapid progress which is being made in each of these fields will necessitate tests, such as those made recently at Las Vegas and Eniwetok, at more frequent intervals.

Research under the atomic-energy program is carried out to achieve the following broad objectives:

1 To increase the efficiency of production processes.
2 To find new and better uses for products.
3 To improve quality.
4 To protect the health of employees in the area where atomic-energy programs operate.

The bulk of this research work is done under AEC contracts by universities, institutions, and corporations, including the multimillion-dollar national laboratories—Argonne, Brookhaven, and Oak Ridge—which are operated for the Commission by private institutions.

Among the corporations under contract for power research work are Westinghouse Electric and General Electric, both of which, working separately, are building prototypes of an atomic engine for submarine propulsion.

A similar propulsion unit for aircraft is being developed, but work on this project is not so far advanced as that on the submarine unit.

#### ATOMIC POWER

Through such military projects, the technical know-how is picked up which will eventually lead to commercial use of atomic power.

Just when atomic power will be on the market, however, is difficult to predict. Many technical difficulties stand in the way of building atomic power plants at costs which will make them economically feasible to operate.

Some time this year, the Commission expects to put a reactor in operation at the 400,000-acre Idaho testing station which will produce over 100 kw of power—but it won't be the kind of plant needed to produce power commercially.

One reason why commercial atomic power isn't "right around the corner" is that with our nation's huge coal and oil deposits an additional power source isn't a critical immediate requirement.

The answer to the uneconomical operating cost of the atomic power plant might be found in the by-products of fissionable materials which these plants "breed" in their operation.

Since these materials are needed by the Government for atomic weapons they might be sold to the Government at costs sufficient to cover the uneconomical operation of the reactor itself.

Electric power groups have shown a great deal of interest in atomic power and the AEC is working closely with these groups.

The industry has submitted several reports to the Commission toward the end of possible utilization of atomic energy for the generation of electric power. See pp. 702 to 705 in this issue.

It will be a long time, however, before atomic energy produces more electric power than it consumes. By 1953 the nation's atomic-energy programs will be consuming about $2\frac{1}{2}$ per cent of the country's total output of electricity.

#### RADIOISOTOPES

The third major atomic product—radioisotopes—unlike atomic power, is very definitely on the market today. In the long run, radioisotopes may constitute atomic energy's greatest contribution, not only in the fields of medicine, biology, agriculture, and scientific research, but in industry as well.

With the view of increasing their use by industry, the AEC asked the Stanford Research Institute to survey industry to determine potential demand and usefulness.

Some possible uses are: sterilization of foods and drugs, tracing of pipe-line flows, radiography, production of certain chemicals, static eliminators, fluorescent lights, and new types of luminescent paints.

To date more than 17,000 shipments of radioisotopes have been made to more than 500 research institutions and industrial concerns in the United States and nearly 200 research institutions abroad.

Present investment in atomic plant and equipment stands close to $2.5 billion which places the AEC near the top of the list in plant assets among the great industrial enterprises of America—larger than either General Motors or the Pennsylvania Railroad.

### PLANT EXPANSION

When the present expansion programs are completed, investment in plant equipment will have reached approximately $4.5 billion.

Two billion of the $48 billion requested by the President for national defense for the fiscal year 1951 will go into the atomic-energy program, an amount almost equal to the entire amount spent under the Manhattan Engineer District. The AEC has asked for an appropriation next year of $1.2 billion.

To run the atomic-energy plants, the AEC has turned to private industry.

E. I. du Pont de Nemours, General Electric, and Union Carbide and Carbon Corporation are responsible for the four major atomic facilities.

During the 12-month period ending March 31, the AEC entered into nearly 11,000 prime contracts and purchase orders with business. The entire atomic-energy program is dependent upon the production know-how and experience of industry.

### URANIUM ORES

Prospects for continued high level of uranium production are encouraging despite the fact that the intensive exploration program has not uncovered deposits equaling the grade or magnitude of the Shinkelobwe Mine in Belgian Congo which is our main supply.

During recent months, new discoveries of ways to recover uranium economically from extremely low-grade ores were made.

As a result of these discoveries, the United States has recently entered into an agreement with the Union of South Africa whereby uranium will be recovered as a by-product of gold production.

Similarly, uranium occurring in phosphate beds of Florida will be extracted at one stage in the manufacture of triple-superphosphate fertilizer.

Refining of uranium ores is being done by private concerns under contract to the AEC.

### SECURITY

Undoubtedly, the atomic-energy program would be much further along than it is today were it not for the necessity for very close security to protect atomic secrets.

But to the knowledge of the Atomic Energy Commission, none of the many atomic-energy developments which have taken place since 1946, when the AEC was set up, have fallen into the wrong hands.

## British Experimental Pile

FOLLOWING an agreement between the atomic energy authorities of Canada, the United Kingdom, and the United States (MECHANICAL ENGINEERING, February, 1951, pp. 142–144), the first detailed description of the construction and composition of Bepo, the British Experimental Pile installed at Harwell, England, has been reprinted in the April 20, 1951, issue of *Engineering*.

Bepo is a graphite-moderated air-cooled pile with a central thermal neutron flux of $10^{12}$ neutrons per sq cm per sec, a critical loading of 28 tons of uranium metal, and a full uranium load of 40 tons, giving rise to an excess reactivity which can be used for producing isotopes or for experimental purposes.

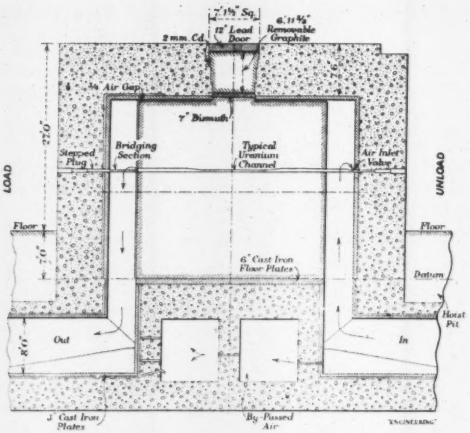


FIG. 1 LONGITUDINAL SECTION SHOWING CONSTRUCTION OF BEPO, THE BRITISH EXPERIMENTAL ATOMIC PILE

The air-cooling system was designed to limit the maximum surface temperature of the fuel elements to 200 C. Loading to critical size took place on July 5, 1948, the uranium being added channel by channel until the reaction became divergent. The power of the pile was continuously monitored in the subcritical state by specially made measuring instruments, and when the pile diverged the power was permitted to rise to 50 watts, with no coolant flowing, before the reaction was shut down by the automatic safety system. This was followed by a gradual work-up to full power, the design maximum flux being reached by Christmas, 1948.

The general construction of the pile itself is illustrated by the longitudinal section, Fig. 1. The reacting part is a cube of graphite of 26-ft sides through which pass 1849 channels about $3^1/_2$ sq in. in cross section and pitched at $7^1/_4$-in. centers. The central 900 of these channels can accommodate bars of uranium machined into cylindrical rods, 12 in. long × 0.9 in. diam, encased in aluminum to prevent oxidation of the uranium and the escape of fission products into the cooling-air stream. Twenty uranium bars are included in each channel leaving 3 ft of empty channel at each end. The channels are loaded radially outward from the center to form a right cylinder of 10-ft radius and 20 ft long. The remainder of the graphite around this central core serves as a reflector to neutrons which would otherwise escape from the central system. In addition to the main channels, this graphite moderator is perforated with holes for experimental purposes, so that the actual structure is somewhat complicated. It is built up of standard blocks each $7^1/_4$ in. × $7^1/_4$ in. × 29 in. long with features machined in their surfaces which provide, when assembled, all the necessary holes. Some 850 tons of graphite required machining into about 25,000 blocks with more than 60 variations in the basic types, and this work was executed in a workshop especially erected for the purpose at Harwell. The general machining tolerance adopted was ±0.0025 in. on all dimensions and such accuracy was maintained that the total height of the 26-ft completed stack was correct to within 0.03 in. From the top and one side, cubes of graphite "thermal columns" project from the main moderator. These columns, by virtue of their distance in graphite from the nearest source of fast neutrons, provide a source of almost pure thermal neutrons.

The 900 central channels are connected at both the air-inlet and air-outlet ends by headers 4 ft wide, extending over the whole graphite face. The headers are connected to the 10-ft × 8-ft underground ducts of the main air system. The main outer structure of the pile consists of a reinforced-concrete and steel shell lined with cast-iron plates 6 in. thick, and constitutes the biological shield for attenuating the intense radioactivity within the pile. The radiation level outside when the pile is running at full power is only twice that which exists when the pile is fully shut down, thus insuring that the sensitive instruments used for experimental work are not adversely affected by background activity. The 6-in. cast-iron shield provides an initial large attenuation of thermal neutrons and x rays, so that the bulk of the radiation energy escaping from the reflector is converted into heat in a conducting and heat-resistance material from which it can be easily transferred to the cooling-air stream circulating past the sides of the cast iron, so avoiding high temperatures in the concrete.

The pile is loaded by pushing in a row of "slugs" from the charge face of the pile, and unloaded by means of steel push rods which push the irradiated uranium slugs out through the unload face into a lead-shielded container. A bridging section is provided connecting each uranium air channel with a hole through the shields so that the uranium bar can cross the air headers. The holes through the shield are, of course, plugged to prevent the escape of radiation at all times other than when an individual channel is being loaded or unloaded. It can be seen from Fig. 1 that all holes through the shield are stepped so that no direct path is provided for the escape of radiation. Loading and unloading machines are carried on 12-ton hydraulic hoists extending the width of the pile, and can be located accurately to any horizontal row of shield holes on the load and unload faces of the pile and traversed on the hoists to select the requisite hole in a given horizontal row.

## Van de Graaff Generator

THE highest-energy machine of its type in this country or in the world—a 5,000,000-volt Van de Graaff generator—is now being used by the Oak Ridge National Laboratory in neutron research at Y-12, but will eventually be moved to a brand new building at ORNL.

At the High Voltage Engineering Corporation in Cambridge, Mass., where it was built, the generator passed the 5.7-million-volt acceptance test, it was reported.

Producing an analyzed beam of four microamperes, the machine's generator tank weighs 19 tons and the accelerator tube is 12 ft long. Differing from the first such machine built by Van de Graaff in the early 1930's, which operated in air at $1\frac{1}{2}$ million volts, this one operates under high pressure—250 psi.

To be used primarily for pure physics research, the machine will also be applicable to shielding studies. The generator will be used for studying fundamental nuclear reaction such as the elastic and inelastic scattering of neutrons and the production of alpha particles.

The range of neutrons produced will run from $\frac{1}{10}$ million volts to 20 million volts. The top energy of the machine is not necessarily the top energy of the particles produced. The conversion of mass to energy accounts for the extra amount.

The highest-voltage machine of its type in the country, its runner-up, a $4\frac{1}{2}$-million-volt machine, is at the University of Wisconsin.

In about 15 months the generator will be housed in a new building on which excavation has already begun across from the new Research Building at ORNL.

A smaller 2-million-volt Van de Graaff generator now being reconverted to positive ions, and a 300-kv ($\frac{3}{10}$ million volts) Cockcroft-Walton machine will also be in the building. These two machines are currently operating in the Laboratory's old powerhouse building.

It is estimated that there are about 50 Cockcroft-Walton accelerators in the country and about 30 of the smaller Van de Graaff generators.

## New Fire Fighting Methods

AS a result of ten years of research and development, the Naval Research Laboratory of the Office of Naval Research has announced new methods of fire extinguishment where oil and gasoline fuels are handled in large quantities.

These methods use mechanically produced foams containing air, water, and protein solutions as extinguishing and protecting agents. The apparatus and chemicals necessary for producing such fire-resistant foams have been improved by the studies at NRL to a point where it is believed that the Navy now possesses the most efficient systems in the world for combating fuel fires aboard ship or at shore stations.

Using laboratory physical and chemical tests and performing thousands of small-scale gasoline and oil test fires, NRL scientists have vindicated the theory that the water in these foams puts out the fire by its cooling effect and only then can a vapor-proof barrier of foam be laid over gasoline to keep the fire from reigniting. The chemical composition of the foam and its water content have been pin-pointed by a carefully planned program of research, and special equipment has been designed to put these foams to work.

Working in co-operation with engineers of the Bureau of Ships, the Naval Research Laboratory recently completed the redesign of large-capacity piped-foam systems aboard U. S. aircraft carriers. Instantaneous operation of these systems, which have been battle-proved in the Korean conflict, is possible through reliable pushbutton remote control, which puts the entire apparatus in motion in just 12 sec

For fighting oil and gasoline fires on land, the laboratory,

FIG. 2 NEW-TYPE TRIPLE-PUMP PRESSURE-FOAM GENERATOR INSURES PROPER MIXTURE OF FOAMITE (LIQUID) WITH WATER AND AIR FOR ATTACKING THE FIRE

in co-operation with members of the industry, has perfected an entirely new foam generating and pumping unit for the Bureau of Yards and Docks.

This equipment is the latest advance in a development program which began at the laboratory in 1942. It is the first motorized equipment to be engineered specifically for fighting only oil and gasoline fires. The triple-pump unit is powered by a 200-hp motor and can deliver up to 2000 gpm of wet fire-extinguishing foams at line pressures of 60 psi.

Using this equipment, mechanical foam can be applied to a large tank fire by means of surface application using pipes installed on the tank for the purpose, or by the subsurface injection method, which utilizes existing oil pipe-line inlets at the bottom of the tank as foam conduits. The foam in this latter method of application rises up through the cold fuel to the burning surface where it cools and extinguishes the fire. This method is important to the Navy because of the protection it affords to the fire fighter, who can control the foam injection at a safe distance from the fire.

The new pressure-foam generator is provided with portable hoseline foam outlets, and the Navy fire fighter has a special adjustable nozzle provided for delivery of foam in a straight stream over long distances or in a protective cone-shaped curtain, depending on the conditions of the fire which confronts him.

# Crash-Injury Research

THE protection afforded by rearward-facing passenger seats was put to a severe test in two recent crashes in Royal Air Force transport-type aircraft, according to a report released by Crash Injury Research, Cornell University Medical College, New York, N. Y. The first crash was that of a Hastings four-engined transport which crashed near Benina, Lybia, in December, 1950; the second case involved a Valetta twin-engined transport which crashed near Stockholm, Sweden, in February, 1951.

The Hastings and Valetta accidents provide the first significant information permitting evaluation of the protection afforded by rearward-facing seats in survivable crashes. The cases are of timely interest in view of the 20*g* rearward-facing seats now being installed in U. S. Navy R6D's (Douglas DC-6), R70's (Super Constellation), and R3Y's (turboprop Consolidated flying boats).

The majority of the material in the Cornell account is quoted directly from RAF reports.

### HASTINGS CRASH

The Hastings transport broke up progressively after the first impact with the ground, leaving a trail of debris which extended for some 360 yd. A detached right wing permitted the aircraft to roll over and the cabin finally came to rest in an upside-down position facing in the reverse direction to the flight path.

The crew compartment was completely wrecked, and the roof of the passenger cabin was severely damaged, having collapsed at the top and on the port side of the fuselage as far down as the escape hatches and windows.

When the cabin roof collapsed, particularly on the left side, the luggage racks came into contact with the headrests of the seats, the latter acting as struts and preventing further collapse. Seats 1 and 35 failed at the base under this abnormal stressing. It is evident that severe head injuries would have been sustained by passengers on both sides of the cabin but for the height of the seats, which in their normal position extend some 4 in. above the head of the average occupant.

The stretcher columns in the roof of the cabin proved a source of danger to the passengers, due to failure of the securing straps which allowed the columns to become detached from the housings.

The escape hatches were removed in flight, prior to the crash, and were loose inside the cabin.

All the passengers were seated in rearward-facing seats stressed to withstand 20*g*. All floor attachments were undamaged, no failure having taken place in either the seat anchorage bolts or anchor plates. After the crash a number of seats were removed and others were loosened by members of the rescue party. From the appearance of those seats which remained firm and in place, it seemed extremely unlikely that any had become loose as a result of the crash. The safety belts on all passenger seats were intact and securely attached to the seats.

One member of the crew was fatally injured by a detached left inner propeller blade, and four more were killed when the crew compartment was crushed during the initial impact. None of the passengers was seriously injured.

The RAF report said that it is considered that the rearward-facing seats were undoubtedly successful and instrumental in reducing considerably the number of head injuries which would have been sustained in the particular crash if the conventional type of aircraft passenger seat had been used.

### VALETTA CRASH

The twin-engine Valetta was returning from Sweden to England with 22 persons aboard, including a crew of three. At 8000 ft the right engine was feathered due to malfunctioning; the pilot turned back and attempted to carry out an emergency single-engine landing under conditions of low cloud and very bad visibility. The pilot overshot the airport and while trying to climb for a go-around, the plane brushed the tops of some slender trees and crashed into the side of a small wooded hill

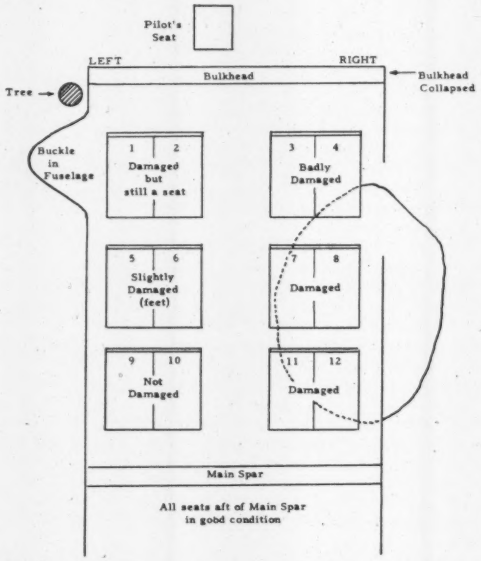


FIG. 3 SKETCH SHOWING CONDITION OF SEATS FORWARD OF MAIN SPAR AND RELATION OF SEATS TO DAMAGED AREAS OF VALETTA'S CABIN

some 500 yd further on. The estimated impact speed was 100 knots. The aircraft stopped in less than the length of the fuselage.

The nose of the ship and cockpit structures were badly demolished. Sections of the cabin forward of the main spar on the right side were severely damaged by a large boulder, which destroyed lower cabin structures in that area. The bulkhead between the passenger compartment and crew's quarters collapsed, particularly on the right side, and the fuselage buckled outward on the left side adjacent to the forward seats. The condition of the cabin aft of the main spar was reported to be substantially intact.

Of the 22 persons aboard, only two, the pilots, were facing forward. The position of the navigator was uncertain; 19 passengers were in rearward-facing seats.

Despite demolition of surrounding cockpit structures, the pilot's injuries were surprisingly limited—a long cut over the left eye, bruises, and some pain in the back, the cause of which had not been determined at the time of the report. His seat buckled but remained in position. The pilot was using a safety belt and shoulder harness which was done up tightly at the time of the accident.

The copilot was fatally injured; he was using the safety-belt part of his harness, but the shoulder straps were not fastened in place.

The navigator, who endeavored to warn the passengers, was not seated at the time of the crash; he was either braced or thrown against the back of the pilot's seat and suffered a comminuted fracture of the left arm.

Except for bruises and a few scratches, 14 of the 19 passengers were uninjured, despite damage in cabin areas. Most of their trivial injuries were caused by flying packages and luggage.

Comments by the RAF medical officer who completed the details of the report are as follows: First, it was a notable success for rearward-facing seats. The only damage to the occupants of these seats came from the ill chance of direct violence from a mighty boulder; second, the importance of the correct use of the Q-type harness was demonstrated once more; third, it served to show that the navigator must take a crash position in the cabin; and fourth, once again flying luggage is shown to be a danger. With rearward-facing seats must go proper storage of luggage.

## High-Compression Engine

FOR more efficient and economical motorcar use, a new "19XX" high-compression engine was introduced at a recent meeting of the American Petroleum Institute by Charles L. McCuen, General Motors vice-president and general manager of GM Research Laboratories Division.

The V-8 engine with 12-to-1 compression ratio, mounted on a 1951 standard Cadillac sedan chassis, registered 29 mpg at 30 mph and about 20 mpg at 70 mph during comprehensive road tests at GM's Phoenix, Ariz., laboratory. At a 40-mph cruising speed it covered 27.6 mpg.

In similar tests a stock 1951 Cadillac V-8 with 7.5-to-1 compression ratio covered 19.8 mpg at 40 mph. This stock engine is rated as one of the most efficient in the automotive industry today, Mr. McCuen said.

Difference in economy performance of the two engines was attributed to the following:

1 Combination of an increased compression ratio and an improved HydraMatic transmission coupled with the 19XX engine. Mr. McCuen said the new unit was developed by GM's Detroit Transmission Division.

2 Fuel of higher octane rating than is available today commercially. It was used in the 19XX engine, while the 1951 stock engine burned gasoline of today's octane level for which it was designed.

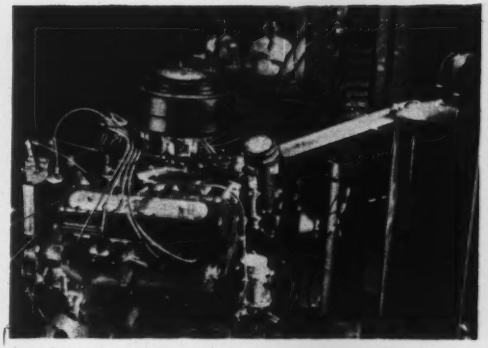

FIG. 4 THE 19XX, AN EXPERIMENTAL V-8 AUTOMOBILE ENGINE WITH 12-TO-1 COMPRESSION RATIO, IS SHOWN DURING BREAK-IN TESTS AT GENERAL MOTORS RESEARCH LABORATORIES

Purpose of the 19XX and other Research Laboratories test engines, was to explore possibilities of utilizing to utmost efficiency type of fuels that petroleum refiners consider feasible in the future.

Impact of these economy gains would affect not only the passenger car, largest consumer of the nation's petroleum reserves, but also farm tractors, military vehicles, boats, and highway trucks, Mr. McCuen declared.

Large gains in economy were confirmed by further tests on the 1951 and 19XX cars made under city-traffic and open-highway driving conditions.

If we can reach the present objective of 12-to-1 engines in production cars, which will give us an additional 30 per cent increase in efficiency, large savings will result to our economy, to the petroleum industry, and to the automobile industry, he said.

Co-operation between the two industries in raising fuel octane levels and capitalizing on them by better engine design would save United States motorists $2,500,000,000 a year in fuel bills and spare the economy 10,500,000,000 gal of gasoline annually, Mr. McCuen estimated.

He said this equaled annual fuel consumption of approximately 15,000,000 vehicles or a total vehicle registration of 17 western states.

He related that for almost 75 years engineers have "recognized that the fundamental method of increasing engine efficiency is to increase compression ratio."

## Gas-Turbine Power Plants

FOUR gas-turbine power plants, first to be installed in the state of Connecticut, will be placed in service early in 1953 by the Connecticut Electric Light and Power Company, R. H. Knowlton, president of CL&P, announced recently.

He said the order for the four gas-turbine units has been placed with the General Electric Company and will be built in Schenectady, N. Y., in a company shop which has been newly equipped at a cost in excess of $4,000,000 for the exclusive production of gas-turbine plants.

These four gas turbines, with a total capacity of over 20,000

kw of electric power, will be used for emergency stand-by power and for peak-load service, Mr. Knowlton said. They are ideally suited for this kind of operation, he said, because they can be brought from standstill to full load and put on the line in approximately 15 min. Its addition to the CL&P system will further enable the company to provide electric power users with high-grade continuous service.

In operation, according to G-E engineers, the unit takes in outside air and compresses it in two stages with an intercooler between the compressors. Each compressor is driven by a separate turbine, with the two turbines in the same casing. One turbine operates at constant speed, driving the 5000-kw generator through reduction gears in addition to the high-pressure compressor. The second turbine is driven by the exhaust from the high-pressure turbine, and operates at varying speed with the amount of load, thus developing higher efficiencies proportionally under partial-load conditions. The exhaust from the low-pressure turbine passes through a regenerator to heat the incoming air from the high-pressure compressor before mixing with fuel in the combustion chamber where the air is still further heated to the design turbine-inlet temperature of 1500 F.

The gas-turbine power plant, they said, has been developed in the last 12 years to the point where it is now ready to assume a significant rôle in the power field, along with other types of power plants. General Electric, a pioneer in gas-turbine development and research in the United States, recently launched a large-scale production program which calls for the manufacture of more than 50 gas turbines per year.

## Strategic Metals and Minerals

A NOTABLE increase in the nation's output of strategic and critical metals and minerals over the next five years is forecast by Secretary of the Interior Oscar L. Chapman as a result of the development by private industry of new mines and the construction of new mills, smelters, refineries, and other facilities for part of the cost of which the Defense Minerals Administrator has recommended accelerated amortization for income-tax purposes.

DMA Administrator James Boyd estimates the annual increased production of copper, zinc, and lead from these new facilities for which DMA has recommended accelerated amortization at 139,000 tons, 90,000 tons, and 35,000 tons, respectively. Other anticipated yearly increases in production of strategic and critical minerals expected to result after completion of construction include 36,000 tons of magnesium, 8,000,000 lb of molybdenum, 1,200,000 lb of cadmium, and 550,000 tons of aluminum.

The largest tonnage increase—15,468,000 tons a year—is expected in iron-ore production, Dr. Boyd said. This figure is conservative, he added, as it includes 5,000,000 tons a year from the deposits of direct-shipping ore being developed in Labrador by the Iron Ore Company of Canada, an American corporation, and this is that company's estimate for 1955. Production from this source is expected to be greater in 1956, 1957, and 1958.

As of June 21, Dr. Boyd said, DMA has recommended to the Defense Production Administration the approval of 137 requests for accelerated amortization of new facilities to be added by the nation's mineral industries. The total investment covered by these requests is about $1 billion. Only $778 million of this amount has been declared eligible for accelerated amortization, and of the smaller amount, an average of about 75 per cent has been allowed. The balance will have to be amortized in the normal fashion.

These facilities, designed to increase production of strategic and critical minerals and metals which have been recommended by DMA for accelerated amortization, are situated in more than half the states of the nation, with one in Canada, and two in the British West Indies. The facilities outside the United States, Dr. Boyd explained, are being constructed by U.S.A. companies in order to provide needed raw materials to defense industries in this country.

The rapid tax write-off benefits, the DMA Administrator explained, were provided by the Internal Revenue Act of 1950. Certificates of necessity, which are granted by the Defense Production Administration, permit companies to depreciate for income-tax purposes a designated percentage of the cost of a new facility over a five-year period. Prior to passage of this Act, he said, the authorized period of depreciation was 15 to 25 years, depending upon the anticipated useful life of the facility.

## New Titanium Process

A NEW process for the production of titanium metal which is expected to reduce costs by more than 80 per cent was announced recently by the Department of the Navy.

Titanium, a light, strong, corrosion-resistant metal, is being used in jet and gas-turbine aircraft and for component parts in ship construction. Present cost of production of titanium is $5 per lb of sponge metal.

Pilot-plant stages in the new production method for titanium have been reached by Horizons, Inc., of Cleveland, Ohio, under contract to the Office of Naval Research. The new process was developed by Horizons, Inc.

Successful commercial production of titanium and titanium alloys at the predicted low cost is expected to help fulfill military demands for a light, strong, corrosion-resistant metal. The lower cost would normally lead to extensive usage in the production of civilian goods.

Titanium, at present, is placed in the metallic category between aluminum and steel. It is 70 per cent heavier and six times stronger than aluminum—approximately 40 per cent lighter and nearly equal in tensile strength to steel.

In resistance to corrosion, it is superior to both aluminum and steel in marine atmospheres. It maintains strength at high temperatures and is particularly suited for aircraft usage.

If the new production method proves successful, titanium is expected to help meet the demand for a new low-cost metal which has many of the qualities of steel and aluminum on a weight-to-strength basis.

Deposits of titanium-bearing minerals are located mainly in the United States, Canada, India, Japan, Norway, and South Australia.

The development of titanium alloys, now in the initial stage, is expected to greatly extend the qualities of strength and resistance to corrosion. The Navy has already achieved a titanium-aluminum-chromium alloy which is expected to have extensive use in jet aircraft.

Several leading aeronautical companies are now evaluating the fabrication characteristics of titanium-alloy sheet for possible use as airframe skins, edges of wings, and ducting of jet planes.

Research in the development of new nonstrategic lightweight metals for ships and aircraft has been in process by the Office of Naval Research for the past five years.

The Horizons project on titanium, begun in early 1950, is regarded as one of the greatest advances during that five-year period.

## Russian Mineral Resources

RUSSIAN oil supplies total more than three times as much as Germany ever had during World War II, and more than half as much as the maximum used by the armed forces of the United States. Russia also has abundant coal resources, with more than 1.6 trillion tons in reserves available. The USSR's iron-ore resources are more abundant than its coal supplies, and possibly even greater than those of any other country. But Russian stockpiles are not large, and there is no reservoir of civilian consumption of minerals to divert to armament.

These and other facts are included in an analysis of Russian resources by Paul M. Tyler, in the June, 1951, issue of *Mining Engineering*. Mr. Tyler is a consulting mineral technologist and economist in Bethesda, Md.

Although Soviet geological reports tend to overestimate tonnages, Mr. Tyler notes that "it must be recognized that an 8.4 million square mile land mass is under consideration" and that "the Soviet program of industrialization has measurably enhanced the defensive strength of the country, as proved by comparing the invasions of Napoleon and Hitler."

The economic yardsticks are too inflexible to employ in measuring the Soviet economy, Mr. Tyler states, pointing out that low grade of ore, poor accessibility, and mining and treatment problems are seldom barriers to exploitation in Russia. As an example he cites the fact that "no private company could undertake the vast exploration now in progress in some of the oil fields between the Volga and the Urals where the yield per well is bound to be small." Slave laborers, numbering between 8 and 15 million, should also be considered in viewing the Soviet economic picture, according to the author.

Russia has made "impressive" industrial progress under its several Five Year Plans, says Mr. Tyler, and comparisons based on conditions under the Czarist regime "show gains that are almost fantastic when expressed in percentages." But he goes on to say that the level of industrial output in the Soviet Union is still low by modern standards, and this low standard is a fundamental weakness because it "affords no emergency reserve." In the event of war, small stock piles would be used up and the Soviet Union would be dependent upon current production.

Mr. Tyler notes as highly significant the fact that the resourcefulness of Soviet engineers is stifled because decisions are made for political rather than technologic or economic reasons; and the fact that the Russians have had less experience than Americans or Western Europeans in handling mechanical devices.

## Diamond-Drill Research

BORROWING from the experience of craftsmen who cut and polish precious gems, Bureau of Mines engineers are now running tests designed to improve the efficiency of diamond-tipped drills used in the minerals industry to bore through hard rock, copper, iron, and other ore deposits, according to a progress report released by Bureau Director James Boyd.

Oddly enough, the techniques developed by generations of commercial gem workers are being applied in reverse in the experiments at the Mt. Weather Testing Adit, known as the Bureau's "hard rock" mining research station, at Bluemont, Va., in the Blue Ridge Mountains.

Gem cutters know that diamonds do not have a uniform hardness, so they take advantage of this fact and speed up their work by cutting and polishing the softer directions and planes of the gem. Conversely, the Bureau of Mines thinks that ore footage can be drilled and the bits will last longer if the hard part of the industrial stone is identified and the diamond is set in the drill bit so that it will dig into the rock and ore.

The diamond drill ordinarily used in the minerals industry for prospecting or development work is a form of rotary drill where the boring work is done by abrasive action of the industrial diamonds set in the drill bit. Nongem diamonds, known as "bort," are used; they are fixed in place by means of casting molten metal around them in the shape of a bit. Normally, the diamonds are set in random fashion without regard to the hard or soft faces of the individual diamonds.

Started less than two years ago at Mt. Weather, the Bureau's research is showing promising results, but the engineers emphasize that the investigation is only in its infancy. Additional experiments extending over several years are planned to gain more conclusive evidence. The current report, the first one issued since the work was begun, simply describes "procedures and preliminary results."

Using Congo industrial diamonds, the Bureau researchers manufactured their own drill bits in the laboratory, drilled dozens of holes in the Blue Ridge rocks, and kept careful records of all experiments. Three types of drill bits tested, with the diamonds oriented in different vector directions, are described as hard type, soft type, and bits where the diamonds were placed at random.

Although the desired orientation of all the diamonds according to the intended vector directions was not achieved in either the hard or soft vector bits, the report states, the test results were "startling" in that the diamond loss per foot drilled was many times less in the bits where the hard faces of the diamonds were placed so that they did most of the abrasive boring.

A copy of the Report of Investigations 4800, "Diamond Orientation in Diamond Bits, Procedures, and Preliminary Results," by Albert E. Long, is available from the Publications Distribution Section, Bureau of Mines, 4800 Forbes St., Pittsburgh 13, Pa.

## Wood-to-Metal Adhesives

DEVELOPMENTS in the new technique of bonding wood to metal with special adhesives are summarized in a pamphlet just issued by the U. S. Forest Products Laboratory, Madison, Wis.

This pamphlet, prepared by H. W. Eickner, laboratory engineer, and R. F. Blomquist, chemist, describes some of the improved types of wood-metal adhesives now commercially available, the conditions of bonding that should be used with these adhesives, and the strength and durability of bonds obtained when the adhesives are properly used. Three main groups of high-strength adhesives are discussed. They are: (1) the direct-bonding, high-temperature-setting, (2) the two-step-bonding with adhesive primer and secondary adhesive, and (3) the direct-bonding room-temperature-setting groups.

Adhesives of the direct-bonding high-temperature-setting group require curing temperatures ranging from 250 to 350 F and are usually composed of two resins, one a thermoplastic and the other a thermosetting resin. This method, the report states, results in joints suitable for such critically stressed structures as aircraft. It has its limitations, however, in that it requires the use of hot-press equipment, and unless special precautions are observed when bonding large areas, blistering of the bonds can occur and high stresses develop when joints are removed from the hot press.

The two-step adhesive process, it is pointed out, avoids these limitations and eliminates the need for hot-press equipment. In this process, a priming adhesive is applied to the metal in much the same way as a paint finish might be applied. The primer is cured in an oven or on hot platens, and the

cured primer is bonded to the wood with suitable wood-working adhesives.

The third group of adhesives described includes those capable of forming direct bonds to metals at room temperature. This type, at the present stage of development, does not produce the same over-all high strength and durability of bonds as do the first two methods, but it has proved successful for applications that are not so critically stressed as aircraft construction.

The report describes the general considerations in the bonding procedures, the preparation of the wood, the cleaning of the metal, and methods of applying the adhesives, as well as the actual bonding conditions. The strength and durability of bonded wood-metal joints tested by immersion in fluids, exposure to high temperatures, and exposure to high humidity are also discussed.

Many fabricators of wood parts, according to the pamphlet, are aware of the improvements in these adhesives, and are choosing formulations best suited to their purpose, thus profitably combining wood and metal to utilize the best properties of both materials.

Copies of the report may be obtained free of charge by writing the U. S. Forest Products Laboratory, Madison 5, Wis., for Report No. R1768, "Adhesives for Bonding Wood to Metal."

# Electroluminescent Light

A NEW principle of producing light—entirely different from either incandescent or fluorescent light—employing thin flat sheets of glowing glass instead of bulbs or tubes, was demonstrated recently by Sylvania Electric Products, Inc., New York, N. Y. It operates at extremely low cost on conventional household alternating current, and it is claimed that it will have an expected life of one to five years.

Sheets of this glowing material can be made in almost any size to provide luminous ceilings, walls, tables, clock faces, stair risers, switch-plates, and signs. This "area" light source, said to be the goal of lighting engineers and architects for generations, is a luminous kind of condenser which Sylvania calls "Panelite." The technical term for this new lighting development is electroluminescence.

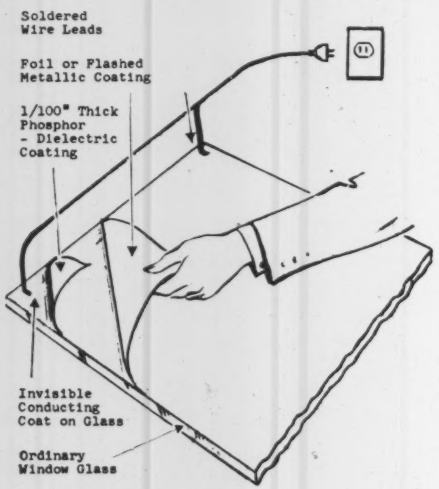


FIG. 5 DIAGRAMMATIC SKETCH SHOWS COMPOSITION OF ELECTRO-LUMINESCENT SHEET

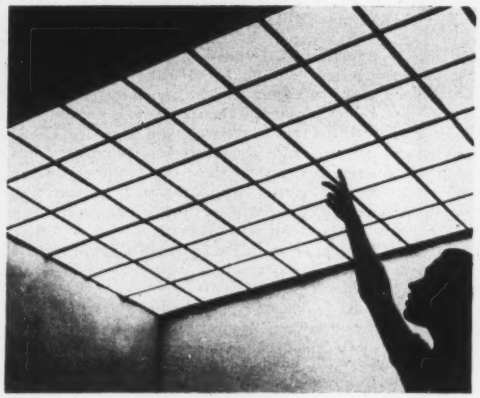

FIG. 6 LUMINOUS CEILING, ONLY $^1/_8$ IN. THICK AND 6 FT WIDE, IS AN ARCHITECTURAL USE FOR THE NEW AREA LIGHTING SOURCE, KNOWN AS PANELITE

The new type of lamp consists of a special sheet of conductive glass, on which is placed a "phosphor-electric" coating, and a layer of vaporized aluminum. These two coatings add less than a hundredth of an inch to the glass itself, thereby achieving almost the ultimate in thinness. Wires are connected to the edges of the sheet to pick up current directly from 110-volt 60-cycle house current. Under this condition, the brightness of the sheets is said to be more than enough for night clocks.

For greater brightness a small inexpensive transformer is introduced in the circuit to bring the voltage up to 400–500 volts, Sylvania engineers explained. This transformer would be no larger than a cigarette package for a panel a foot or two square. The transformer multiplies the light output by twenty. It is said to be ample for low-level illumination of restaurants, elevators, theater aisles, and many other decorative and architectural applications.

So economical is the current consumption of the new lighting method that many of the applications not requiring a transformer, such as wallplate switches, clock faces, and safety lights, can be permanently connected to house or building wiring to run 24 hours a day. Most uses of this sort would be rated at about $^1/_{25}$ of a watt, costing not over 2 or 3 cents per year to operate continuously. Even with the use of transformers, which build up brightness and therefore require more power, a 4 ft × 6 ft panel consumes less energy than a 25-watt light bulb.

The panels will be made in a variety of colors, including white, a golden yellow, and a light blue. A brilliant green color is the only one commercially available at present.

# Long-Distance Dialing

THE first coast-to-coast dial call by a telephone subscriber will be made this fall, the New Jersey Bell Telephone Company announced recently.

Equipment required for the initial use of coast-to-coast dialing by customers will be installed in the Englewood, N. J., exchange.

The intricate switching apparatus, development of which

climaxes years of research by the Bell Telephone Laboratories, will enable subscribers to span the continent through 10 pulls of the dial instead of the customary seven now used in completing calls to shorter distances.

In the initial phase of cross-country dialing, 10,000 customers in the Englewood exchange area will be able to dial directly for the first time, to any of 11,000,000 telephones in such cities as San Francisco, Chicago, Cleveland, Detroit, and Boston, and many of their adjacent suburbs, the company said.

Long-distance calls which averaged 14 min to connect 30 years ago and which average two minutes today, may be completed in a matter of seconds with long-distance dialing.

A country-wide numbering plan, which includes parts of Canada, plays a key role in the nation-wide dialing system. In all, there are more than 80 numbering plan areas, each of which is assigned a special three-digit code.

For example, on a call from Englewood to San Francisco, the subscriber will first dial the latter's code of "3-1-8" and follow immediately with the number of the telephone being called. On a call to a subscriber with the number GArfield 1-9950 in San Francisco, the calling party will dial the 10-digit combination of 318-GA 1-9950.

The equipment installed in the Englewood central office stores up the digits dialed and as soon as the tenth digit is recorded, the call is automatically switched over telephone highways to the called telephone in San Francisco. (Calls to some party line telephones may require 11 digits before the call can be completed.)

Similarly, a preceding code of "6-1-7" will speed a call to a Boston location.

FIG. 7 THIS ELECTRONIC TRANSLATOR BEING ASSEMBLED BY A BELL TELEPHONE LABORATORIES ENGINEER IS PART OF THE INTRICATE DIAL EQUIPMENT WHICH MAKES POSSIBLE CROSS-COUNTRY DIALING BY SUBSCRIBERS

At the start of the Englewood dial trial, 13 codes will be in use covering areas served by 800 central offices. In addition to the codes for San Francisco and Boston, other areas within the dialing range of Englewood subscribers will be set up.

Additional areas in New York State will also be within reach of Englewood subscribers through the use of two other codes.

The trial-customer long-distance dialing is limited to Englewood, and the company emphasized that subscribers in the 13 areas will not at this time be able to dial Englewood directly even though they can receive direct dial calls from the Englewood subscribers.

Keeping track of the charges on customer-dialed long-distance calls will also be done automatically. The company said installations of Automatic Message Accounting equipment will register each step of a call, including the number of the calling telephone, the exchange and number of the called telephone, date and time of day, and length of call.

The information is recorded on paper tape which is later run through a decoding machine which assembles, translates, sorts, summarizes, and prints the information in a form that can be used in preparing customers' bills. Busy and don't-answer calls are automatically eliminated by the AMA machinery.

The first coast-to-coast dial call, the company pointed out, comes at a time when the world is observing the 75th anniversary of the invention of the telephone by Alexander Graham Bell and 36 years after the first coast-to-coast telephone call in 1915.

## Electronic Plastics Production

THE possibility of making solid plastics from liquid raw materials by bombarding them with high-voltage electron beams, or cathode rays, is foreseen as a result of experiments reported by Dr. John V. Schmitz and Elliott J. Lawton, scientists of the General Electric Research Laboratory.

An essential part of the manufacture of plastics, they explained, is a process called "polymerization," in which small groups of atoms are linked together to form long chains. The individual groups can move around freely, so that they form a liquid, but the chains make a rigid, solid structure. Generally, chemical means are used to initiate the polymerization which, once started, proceeds rapidly in a chain reaction.

The scientists have found that a beam of electrons with energies of 800,000 volts, brought into the open air, is able to cause such polymerization. Their results are reported in a recent issue of *Science*.

Most of their experiments were performed with a compound known as TEGMA (short for tetraethyleneglycol dimethacrylate) but they found that various other compounds could similarly be polymerized with the speeding electrons. Among these are styrene, acrylonitrile, and methacrylates. The latter, under a variety of trade names, are widely used in a water-clear form to make hair brushes and many other objects.

Dr. Schmitz explained that the joining together of the individual molecular units to form the long chains, or polymers, results from a rearrangement in the electrons in the atoms of which the units are made, since some of these electrons are responsible for the bonds that hold the structure together. Ordinarily they are rearranged by the action of chemicals. In the new experiments, the same effect is obtained by firing other electrons, with high speed, at the liquid made of the separate units. These hit a few of the atoms, either knocking their electrons out, or else sticking and increasing their number. With a small proportion of the atoms thus altered, the reaction starts and proceeds through the volume of liquid exposed to the rays.

Dr. Schmitz stated that Dr. William D. Coolidge, retired director of the G-E Research Laboratory and now x-ray consultant, did early work in this field. Experiments he conducted in 1925 showed, for example, that these rays could turn castor oil into a solid form. Other compounds, such as ethylene, were similarly polymerized.

The recent experiments were performed with a modified million-volt x-ray machine. In experiments previously reported, Mr. Lawton, with other collaborators, has shown that these rays are capable of sterilizing bread, so that it will last indefinitely without molding. More recently, he showed that they could convert sawdust into a form which can be digested in a cow's stomach.

## Coal Consumption

INCREASE in electric power output is being matched by a big increase in coal tonnage in electric power generation and coal is heading for a new all-time high. An analysis, by the Bituminous Coal Institute, of Federal Power Commission figures dealing with production of electric energy for public use reveals that while the electric power output in the first four months of 1951 was 16 per cent ahead of the corresponding period last year, coal consumption in this power output was 24 per cent ahead of the comparable 1950 figures.

The coal consumed January through April was 35,122,000 tons, as contrasted with 28,265,000 in the same period a year ago. At the present rate, BCI said, electric-utility coal consumption for the year will pass the 100-million-ton mark. The previous high was in 1948 when bituminous coal consumed by the utilities amounted to 95,620,000 tons, plus 3,847,000 tons of anthracite.

There has been a sharp falling off in the consumption of oil by the electric utilities, so far this year, despite the rise in electric power output. In the first four months, the consumption of oil, measured in terms of coal equivalent, amounted to 5,358,000 tons, hardly one seventh as much as the coal that was consumed. The figure for oil in the corresponding period a year ago was 6,828,000 tons, in coal equivalent.

The consumption of gas in electric power generation showed a small increase as compared with last year. Electric energy generated by water power, from January through April, was also ahead of 1950.

Total electric power output for the four-month period amounted to 119,851 million kwhr compared with 103,575 million kwhr in the same period last year. Coal, oil, and gas, together, accounted for 84,533 million kwhr and, of these three, coal's share was more than twice as much as the other two combined, the Bituminous Coal Institute pointed out.

The BCI analysis concluded with the statement that while the electric utilities are using more coal than ever before in electric power generation, they are getting more kilowatt-hours per ton than ever before, thanks to the combined efforts of the engineers of both industries to obtain higher efficiencies in coal utilization. This has been achieved through a better preparation of the coal, coupled with significant improvements in boiler-room techniques. As a result, one pound of coal in electric power generation goes as far as three pounds did 30 years ago.

## New Shale Plant Unit

THE Department of the Interior announces the award of a $333,870 contract to Blaw-Knox Construction Company, Pittsburgh, Pa., for the design and construction at Rifle, Colo., of a demonstration-scale retort that will employ a new and promising process developed there for continuous extraction of oil from shale.

The new demonstration unit, with a capacity range from 150 to 400 tons of oil shale daily, will be patterned after a 6-ton per day pilot plant that has proved the new "gas-combustion" process both the most efficient and most economical ever tested at Rifle, according to Boyd Guthrie, chief of the Bureau's Oil-Shale Demonstration Plant.

Major objectives of the new retorting plant, as listed by Mr. Guthrie, are (1) to determine cost and yield data that will permit an accurate evaluation of the gas-combustion process; (2) to provide the technical information that industry needs to design commercial plants; and (3) to supply crude shale oil in the quantities required for the Bureau's refining studies. Plant design will permit a wide range of experimental operating conditions, he said, and will include all necessary instrumentation for accurate process control and exact measurement of results.

The new gas-combustion process has two novel and important features, Mr. Guthrie said.

First, the process gets its name from the fact that it produces and uses as a source of heat for retorting a low-Btu gas obtained from the shale and burned in the presence of air.

Second, unlike most other retorting processes, it requires neither water, air, nor an elaborate system for condensing the liquid products that come from the retort in the form of mist.

Even more important, Mr. Guthrie said, investment and operating costs for the new process will be substantially lower than those for other processes tested at Rifle, and product costs thus also will be lower.

Crushed oil shale is fed into the top of the vertical retort and moves downward by gravity against a rising stream of gas. Air is injected near the center of the vessel and the gas burned to provide heat for retorting. As the rising gas from the combustion zone and the downward moving shale pass each other, the shale is heated and the gas is cooled. Upon leaving the retort, the oil mist-laden gases pass through an oil-collecting system. Part of it is returned to the bottom of the retort where it is preheated by spent shale before entering the combustion zone. The large volume of excess gas remaining could be burned to generate heat or power.

## Bomb Glass

THE development of a special window to minimize the effects of explosive forces has been announced by the Pittsburgh Plate Glass Company, Pittsburgh, Pa. A glass-plastic laminate to be known as Flexseal bomb glass, the product is said to virtually eliminate the dangers of flying glass in explosion areas.

The Flexseal bomb window will resist normal atmospheric pressures because of the special properties incorporated in its design. When these are exceeded by a bomb blast or pressure wave, the window will open automatically by folding about its edges. This action releases the pressure, preventing the window frame from being blown in, and greatly reducing the possibility of flying fragments.

The window consists of three layers laminated into a single unit. The outer layer is a sheet of glass, the middle layer a partially segmented sheet of polyvinyl butyral plastic, and the inner layer consists of four triangular-shaped pieces of glass, the central area edges of which register with the segmented edges of the plastic. The plastic layer extends beyond the glass edges and is bolted to the window frame to serve as hinges, thereby permitting the four segments to open like doors when the outer plate of glass is broken.

# ASME TECHNICAL DIGEST

*Substance in Brief of Papers Presented at ASME Meetings*

## *Industrial Instruments*

**The Impact of Servomechanism Techniques on Instrumentation,** by Arthur Porter, Ferranti Electric Ltd., Toronto, Canada. 1951 ASME Semi-Annual Meeting paper No. **51—SA-22** (mimeographed).

A REVIEW of some advances in the theory and design of servomechanisms is given with special reference to their application in the general field of instrumentation.

It is pointed out that the highly developed frequency-response method applied to servo-system design is of comparable value in the development of process control and allied systems. In addition, the advent of new components and practical techniques in servo development will be of increasing importance in a wide range of instrumentation problems.

The importance of designing control systems which include human operators, in accordance with psychological and physiological principles combined with the basic concepts of feedback control systems, is stressed in some brief notes on the subject.

Finally, some recent developments in the servo art are introduced with the object of acquainting instrument engineers with ideas which may contribute to advances in instrumentation in the future.

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**On the Automatic Control of Generalized Passive Systems,** by Kun Li Chien, John A. Hrones, Mem. ASME, and James B. Reswick, Massachusetts Institute of Technology, Cambridge, Mass. 1951 ASME Semi-Annual Meeting paper No. **51—SA-29** (mimeographed; to be published in Trans. ASME).

THE dynamic behavior of a multiple-capacity passive system is compared to that of a single-capacity system of appropriate "time constant with a finite time delay." Such a comparison indicates that the latter system reproduces the dynamic behavior of the multiple-capacity system with sufficient accuracy for most engineering purposes. This fact makes it possible to characterize such systems by a single parameter, the ratio of the time constant ($L$) of the single-capacity system to the delay ($D$). Values of the control constants for various degrees of stability are plotted against this ratio ($4D$) for proportional, proportional plus integral, proportional plus integral plus derivative-type regulators. An electronic analog computer was used in obtaining the data.

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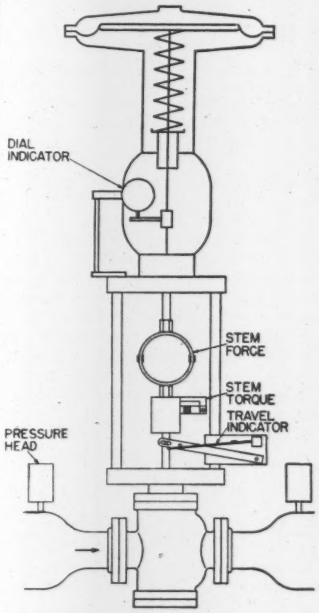
**Dynamic Force Reactions in Double-Ported Control Valves,** by C. F. King, Jun. ASME, and G. F. Brockett, Fisher Governor Company, Marshalltown, Iowa. 1951 ASME Semi-Annual Meeting paper No. **51—SA-1** (in type; to be published in Trans. ASME).

A CONTROL valve is normally the final control element in an automatic controller, and its function is to control continuously the rate of flow of a fluid in accordance with the dictates of a controlling instrument. The control valve




DIAGRAMMATIC SKETCH OF FORCE-MEASURING EQUIPMENT



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accomplishes this by positioning an inner valve or plunger, which varies the area through which the fluid or control agent must pass.

With high fluid flow rates through double-ported, semibalanced control-valve assemblies, V-port inner valves may be subjected to seriously high torsional forces, and plug-type inner valves of symmetrical design to vertical forces of great magnitude. These forces are proportional to the mass velocity of the flowing fluid at the body inlet.

The proportionality constant for torsional forces on V-port inner valves must be determined by test for each valve size and design. However, after these factors have been determined, it is possible to predict the maximum pressure drops that can be handled successfully. It is also possible, by proper inner-valve design, to reduce these torsional forces by a substantial amount.

The mass velocity-vertical force proportionality factor for conventionally designed plug valves is approximately 1.7. It is possible, by using different contours, on the top and bottom plugs, to reduce this factor to a point where vertical force reaction is not of grave concern.

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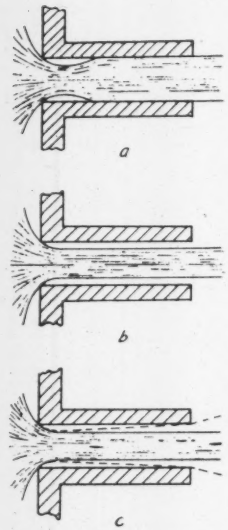
**Metastable Flow of Saturated Water,** by Joel F. Bailey, Jun. ASME, University of Tennessee, Knoxville, Tenn. 1951 ASME Semi-Annual Meeting paper No. 51—SA-55 (mimeographed; to be published in Trans. ASME).

THIS paper discusses the nature of the flow of saturated and nearly saturated water into regions where the pressure is less than the saturation pressure. It presents a method of computing the mass rate of flow through orifices and nozzles which is based on the rate of evaporation from a metastable liquid core into a surrounding ring of vapor. The analysis is based upon experimental investigations and is restricted to adiabatic flow conditions.

It is shown that in the flow of saturated or nearly saturated water, complete metastability (the entire stream being a superheated liquid) occurs within an orifice and may occur in a well-shaped nozzle.

In an orifice the flow is effectively that of a completely metastable liquid because the length of the orifice is zero. Actually, it is not practical to make orifices of zero length. However, if the length is not too great, the contraction of the liquid jet is sufficient to permit vapor to form within an orifice of finite length without restricting the flow. In the case of a well-designed nozzle the




FLOW THROUGH A SHORT TUBE
(*a*) Tube flowing full; (*b*) Tube not filled; (*c*) Vapor forming at stream surface.

completely metastable state persists for only a relatively few degrees of superheat. It is shown that Danforth obtained complete metastable conditions for about 7 psi after the saturation pressure was reached. For discharge pressures appreciably below the saturation pressure complete metastability does not exist in a nozzle and the fluid consists of a metastable liquid core surrounded by a ring of vapor.

Equations for computing the mass flow rate of saturated or nearly saturated water through nozzles are given. These are based on the rate of evaporation from the liquid core into the ring of vapor and give results which agree rather well with existing experimental data.

Using the equations, mass flow rates may be computed accurately. The equations will also give flow rates through nozzles to within 10 per cent for initial pressure up to 100 psia.

# *Plastics*

**Electric Control of Air-Flow Porosity in Plastic Sheet Materials,** by J. J. Suran, J. W. Meaker & Company, New York, N. Y. 1951 ASME Semi-Annual Meeting paper No. 51—SA-2 (in type; to be published in Trans. ASME).

IN the application of plastic sheet materials to commercial uses, one of the serious objections which often arises is the impermeability of the material to fluid flow. It is thus desirable to devise a process which permits the control of porosity in sheet materials. Such a process has been developed by the author's company, and is commercially known as "electroventing." Electroventing consists in passing electric sparks through the sheet material in such a manner as to produce a desired distribution of holes, and holes of a specified size. The combination of size of holes and number of holes will determine the fluid-flow characteristics of any material.

Application of the process has already been made to the venting of paper, hats, and shoes; its possibilities in the field of plastic sheet materials are numerous. A porosity-control process in the manufacture of paper permits the paper manufacturer to concentrate on the strength of sheet without regard to porosity considerations; thus one of the variables in the manufacturing stages is removed. When cellulose or plastic films are applied to the packaging of food, a need for porosity may arise. Electroventing provides a means of adding any desired porosity to the film to meet various types of packaging requirements. In the application of plastic materials to apparel use, occasions arise where porosity becomes a critical consideration. By electroventing, pores of a permanent nature may be processed into the plastic film and thus provide it with the "breathing" quality so often desired in apparel materials. When fully developed in the numerous fields where it may apply, electroventing undoubtedly will open up large new areas for the use of plastic sheet materials.

# *Dust Emission*

**Methods of Reducing Dust Emission From a Spreader-Stoker-Fired Boiler Furnace,** by W. C. Holton and R. B. Engdahl, Mem. ASME, Battelle Memorial Institute, Columbus, Ohio. 1951 ASME Semi-Annual Meeting paper No. 51—SA-20 (in type; to be published in Trans. ASME).

FORTY-SEVEN tests were made on a continuous-ash-discharge spreader-stoker-fired boiler to determine means of reducing dust emission. In addition to burning rate, variables investigated were the amount of overfire air, the use of air, steam, and steam-air jets, the location of steam jets, the degree of reinjection used, and coal size. These tests showed that the use of overfire-jet turbulence decreased smoke density, carbon

loss, and dust emission from the furnace. It was found that steam jets located low in the rear wall gave the lowest dust emission. Reinjection of all collected cinder decreased carbon loss to one fourth of its value without reinjection, but doubled the dust loading of the stack gases. The use of double-screened coal was found to reduce dust emission appreciably.

# *Management*

**Economic Basis of Engineering Design and Planning,** by R. S. Steinbock, Sarnia, Ontario, Canada. 1951 ASME Semi-Annual Meeting paper No. **51—SA-43** (mimeographed).

WHEREVER economic considerations govern investment problems, the matter can be readily solved in three simple stages.

First, the minimum pay-out period must be established. This will vary not only as financial conditions change, but actually from job to job with the proportion of noncapitalized investment.

The second step should evaluate the percentage net return on the investment after the first year.

Third, the actual pay-out time must be calculated to establish whether it lies within the specified requirements as found in step one.

To solve such problems the formulas given in the text of this paper will offer a quick method, since direct substitution eliminates the need for calculation of actual amounts payable in taxation or to be written down for depreciation. The graphical method, however, is probably the easiest and quickest. The range of the curves will probably cover all but a few cases met with in commercial practice.

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**Nonproductive Time and Its Practical Implications,** by Adam Abruzzi, Stevens Institute of Technology, Hoboken, N. J. 1951 ASME Semi-Annual Meeting paper No. **51—SA-36** (mimeographed).

MOST plant managers are not aware of the fact that the study of nonproductive time and its causes is probably the most effective way to increase the production output per man-hour, thus achieving sizable economies in production costs. The study of the causes of nonproductive time also provides extremely valuable information on where and how major improvements can be made in the technology and the work methods used in production, leading again to sizable economies in production costs.

To obtain data on the relation between productive time and nonproductive time, extensive research studies were made in two plants in the ladies' garment industry. These plants were selected because they had quite different degrees of technological development and managerial control. Their selection thus made it possible to determine whether the conclusions obtained were affected by the operating characteristics of the individual plant.

The studies themselves lasted from four to eight hours each and were made on 100 workers assigned to 30 representative sewing and pressing operations. These operations were of the type usually referred to as "man-controlled," in which the worker exercises almost complete control over the pace at which he will work.

In each of these studies, continuous stop-watch readings were taken of (1) The time required to perform each subdivision of the operation; and (2) the time spent unproductively (i.e., consumed by delays). The nature of the delays encountered was also recorded and classified into two major groups. Following the usual terminology, the first group included unavoidable delays like machine breakdowns, for which the worker is not held accountable, and avoidable delays like talking, for which he is.

Distinguishing between productive time and nonproductive time in this manner has an obvious but fundamental advantage. It permits an analysis to be made of the relationship between the nature, frequency, and duration of delays on the one hand and the work method and work pace on the other. To do this, it was first necessary to develop a common denominator for operations of different types. In this case, the common denominator selected was the ratio of the production standard to the average time required to complete a production unit. This index of relative productivity was then computed for a group of representative operations and operators.

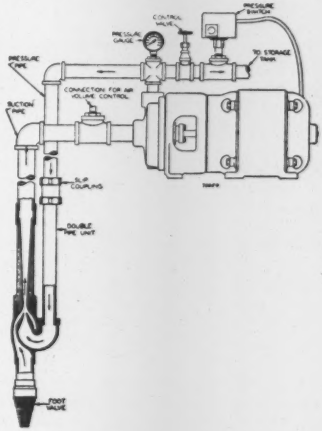
It is shown that the percentage and duration of delays recorded for a worker is closely related to his relative productivity. A particularly significant result is that workers with smaller indexes (i.e., with relatively poorer productive efficiencies) have by far the greater total percentage of delays and use much more of their time unproductively. A closer examination reveals that the differences in the total percentage of delays between these workers and the others are largely the result of their greater percentages of personal delays. This strongly suggests that the much smaller total percentages of delays recorded for the workers with larger indexes result from their ability to minimize personal delays.

The same workers, however, were apparently unable to reduce the percentage of unavoidable delays nearly as much, for, as their definition implies, such delays are not usually subject to the worker's control. In general terms, this means that, with experience, a worker should be able to minimize the percentage and duration of personal delays, although he will not be able to do very much about unavoidable delays, which depend upon the nature of the production process and the production-control system.

# *Hydraulics*

**Centrifugal-Jet Pump Combinations,** by J. W. McConaghy, Mem. ASME, Ingersoll-Rand Company, Phillipsburg, N. J. 1951 ASME Semi-Annual Meeting paper No. **51—SA-27** (in type; to be published in Trans. ASME).

THE widespread use of the water jet combined with a centrifugal pump to create what is commonly called a "jet pump" for domestic water systems, directs




TYPICAL DEEP-WELL ARRANGEMENT OF A JET PUMP AND A CENTRIFUGAL

attention to the determination of its operating characteristics in terms of its components. The relative importance of this type of pumping equipment is illustrated by Department of Commerce data which show that in 1948 fifty-six companies shipped 649,143 units having a

factory value of $50,704,294. Of these, 325,220 were of the jet type valued at $27,298,250. While the units are usually small and can be tested readily to obtain data on the operating characteristics, an engineering analysis would serve to emphasize the essential design constants.

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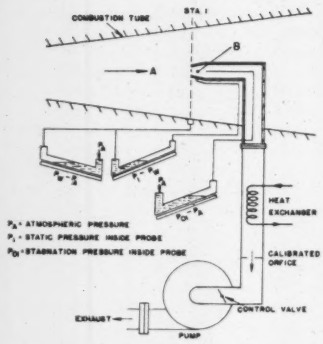
**Nondimensional Compressor Performance for a Range of Mach Numbers and Molecular Weights,** by H. E. Sheets, Mem. ASME, Goodyear Aircraft Corporation, Akron, Ohio. 1951 ASME Semi-Annual Meeting paper No. 51—SA-19 (in type; to be published in Trans. ASME).

THE performance of centrifugal compressors is analyzed on the basis of nondimensional pressure and impeller-exit flow coefficients $\psi$ and $\phi_3$. Use of these coefficients for impellers of high solidity permits presentation of compressor performance in a single curve for all conditions up to a critical Mach number. To show compressor data in a characteristic family of curves, performance is represented by pressure and flow coefficients $K_P$ and $K_Q$. These coefficients take into account the coefficient of compression and the molecular weight simultaneously with the induction temperature. Test data for two compressors are presented over a range of Mach numbers from 0.36 to 2.0, and molecular weights in the range of that of air to heavy refrigerants. The test data show experimental verification of the fact that for centrifugal turbomachines with blades of high solidity the performance is a function of the Mach number only.

# *Heat Transfer*

**A New Method for Determining the Static Temperature of High-Velocity Gas Streams,** by John A. Clark and Warren M. Rohsenow, Jun. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1951 ASME Semi-Annual Meeting paper No. 51—SA-33 (mimeographed; to be published in Trans. ASME).

THE general problem of measuring the static temperature of gases flowing at high and low temperatures and at low and high velocities is reviewed. Thermodynamic methods are discussed and a new method is presented with experimental results. This proposed temperature-measuring method has several important and desirable features: (1) The calculated static temperature is practically independent of gas composition in so far as composition is characterized by the specific-heat ratio, $k$, (2) like the thermocouple the temperature determined by this method is a "point" value, not a mean value at the flow cross section where the measurements are made, (3) unlike the thermocouple the method improves in accuracy as both the gas temperature and velocity are increased, and (4) the instrument required is relatively simple to build, is not subject to the effects of corrosion, and is extremely rugged when installed. The instrument requires no special handling and can be installed conveniently and easily in ducts of any shape or in a stream of unconfined gas.




SCHEMATIC DIAGRAM OF INSTRUMENTATION FOR PROPOSED METHOD

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**A New Method of Determining Thermal Diffusivity of Solids at Various Temperatures,** by D. Rosenthal, Mem. ASME, and A. Ambrosio, University of California, Los Angeles, Calif. 1951 ASME Semi-Annual Meeting paper No. 51—SA-39 (mimeographed; to be published in Trans. ASME).

THE method under review affords a rapid means of determining thermal diffusivity and is especially suitable to measurements at high temperatures. The theory of moving heat sources is the basis for this method. When the theory is applied to the case of unidimensional heat flow in a long prismatic bar being heated by a moving point heat source, an equation which permits the computation of thermal diffusivity at each temperature is obtained. The experimental technique involves the measurement of the temperature-time history at a single point of the bar, using two different heat source velocities. The method was tried on a commercial "yellow" brass tube, but the equation derived for the computations proved to be unworkable due to the poor accuracy attending the evaluation of the first and second-order derivatives of the temperature-time curves. To avoid this shortcoming another equation was derived by assuming that the thermal properties of the bar are constant in small intervals of temperature. This equation gives average values of diffusivity in the small intervals of temperature, rather than a specific value for each temperature. This approximation notwithstanding, the intervals of temperature could be made small enough to determine the values of thermal diffusivity of the brass specimen in the range 100 C to 400 C with a repeatability of ±3 per cent. These computed values compare favorably with those found in the literature.

It is concluded that the new method has definite advantages over existing ones, especially with respect to the application to high temperatures. These advantages are as follows: (1) The properties of the material need be assumed constant only in small intervals of temperature; (2) the quasi-stationary state is easily obtained; and (3) the mathematics involved in the calculation of the thermal diffusivity need no simplification and are straightforward.

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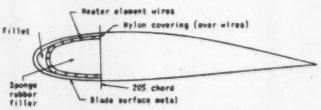
**Further Remarks on Intermittent Heating for Aircraft Ice Protection,** by Frederick Weiner, Jun. ASME, University of California, Los Angeles, Calif. 1951 ASME Semi-Annual Meeting paper No. 51—SA-38 (mimeographed; to be published in Trans. ASME).

AN electric analog technique is used to solve the equations for intermittent heat transfer during icing conditions. The results of the analog investigation applied to an internally heated propeller show good agreement with measured time-temperature data previously reported in the literature. The greater




DETAILS OF HEATER CONSTRUCTION IN AN INTERNALLY HEATED PROPELLER BLADE

effectiveness obtained by using larger amounts of power for shorter time intervals is demonstrated. The power density requirements over the heated area are shown to be different for the case of intermittent heating as compared to steadily heated ice-prevention systems. A more effective heater design, utilizing a conductive coating on the blade surface, would diminish the energy requirements considerably.

# Production Engineering

**The Maintenance Grinding of Cutting Punches and Dies,** by H. B. Elliott, Northern Electric Company, Ltd., Montreal, Quebec, Canada. 1951 ASME Semi-Annual Meeting paper No. 51—SA-26 (mimeographed).

THE Northern Electric Company of Montreal is the supplier of telephone equipment to the Bell Telephone Company of Canada. In the manufacture of this equipment, some 7000 punches and dies are on the shelves of the tool cribs in the various product shops. Four thousand of these are cutting punches and dies and this paper presents the means which have been developed to increase the operating life of these tools per grind and to increase their ultimate life beyond previous expectancy.

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**Plan For Preventing Excessive Maintenance of Machining Tools,** by Edward Griffiths, Mem. ASME, Westinghouse Electric Corporation, Pittsburgh, Pa. 1951 ASME Semi-Annual Meeting paper No. 51—SA-16 (mimeographed).

IT is quite feasible for a company to plan and direct a program that will provide basic information which can be used to improve quality and reduce tool failures and production losses to a marked degree. If such a program is carefully planned and operated, supervision will find that instead of detail tool failures occupying a major portion of their time and, accordingly, interfering with other important supervisory responsibilities, they will be able to direct and control the operation of tool investment much more effectively and with a minimum of distraction from other duties.

Such a plan is now in operation in a number of Westinghouse Electric Corporation's Divisions and has been developed for application to tools in the following important classes: (1) Punch-press metal-stamping and forming tools; (2) miscellaneous tools, such as milling cutters, drills, taps, reamers, gear hobs, etc.; (3) hot-pressing, hot-forging, and permanent molding, plastic-molding, and die-casting.

In fact, any type of tool can be studied in much the same manner.

Basically, the plan requires formation of a Tool and Die Committee composed of personnel thoroughly trained and familiar with the relative tool-construction and application problems involved and with sufficient time and responsibility to collect and analyze information relative to tool failures as they occur. Periodically, meetings are held with responsible persons from production, tool design, tool construction and maintenance, quality control, and product-design engineering for the purpose of discussing causes of failures and formulate plans to reduce or eliminate these failures.

The method of approach is basically the same for all tools but since punch-press, metal-stamping, and forming tools represent the largest dollar investment of any class of tools used at Westinghouse, application of the plan was made to this group first. This report is confined to the use of metal-stamping dies, touching briefly on the related problems of punch presses and feeders.

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**The Reliability of Metal-Cutting Data,** by L. V. Colwell, University of Michigan, Ann Arbor, Mich. 1951 ASME Semi-Annual Meeting paper No. 51—SA-28 (mimeographed).

SEVERAL types of metal-cutting data and information, particularly the relative machinability rating, are questioned as to their reliability for certain applications. Examples are given of the failure of machinability ratings to predict performance. The nature of machinability is reviewed and a new three-part program is proposed for the accumulation of new and more useful data.

This program proposes the following:

1 Standardized tests like the familiar physical-property tests to be used generally in connection with all metals for the purpose of obtaining a few specific quantities on a lot of materials.

2 Comprehensive empirical tests of a few representative metals; to be undertaken jointly by engineering societies and the suppliers of basic metals for the purpose of learning the most important differences between these materials for all significant machining operations.

3 Expanded fundamental research for the common causation factors of metal cutting. This is the only approach which can simplify the whole problem eventually. Support should be generous and the work should be carried on in many research centers.

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**Drilling of Cast Iron With Cemented Carbide-Tipped Drills,** by E. J. Weller, General Electric Company, Schenectady, N. Y., and F. W. Lucht, Mem. ASME, Carboloy Company, Inc., Detroit, Mich. 1951 ASME Semi-Annual Meeting paper No. 51—SA-35 (mimeographed).

LABORATORY tests reported in this paper show that when cast iron is drilled with carbide-tipped drills, the horsepower requirements vary from approximately 2.4 hp per cu in. of cast iron removed per min with sharp drills 0.246 in. diam running at 130 fpm with 0.006 in. feed per revolution, down to approximately 0.4 hp per cu in. of material removed per minute with sharp drills running at 56 fpm at a feed of 0.015 in. per revolution. For other machines and conditions, allowances may be made for machine efficiency.

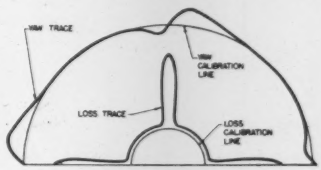
The production runs illustrate some of the gains which can be realized by using cemented carbide-tipped drills. Satisfactory results have been obtained with all carbide-tipped drills used up to this time. Carbide-tipped drills have yielded an increased number of holes per grind when operated at the normal high-speed-steel drilling speeds and at increased drilling speeds. Increased speeds also result in decreased drilling time. In either case, drill-press down time is decreased and fewer drills must be resharpened for each 1000 holes drilled.

# Gas Turbines

**High-Speed Cascade Testing Techniques,** by F. H. Keast, A. V. Roe Canada Ltd., Malton, Ontario, Canada. 1951 ASME Semi-Annual Meeting paper No. 51—SA-31 (mimeographed).

THIS paper describes a cascade wind tunnel used by the author since 1948. Such auxiliary equipment as an automatic traverse and recording gear and a wedge-shaped probe are described. Some results are presented with a method of analysis for turbine cascades which converts the cascade results into a turbine performance chart. The existence of a critical load factor results from this analysis.

For axial-compressor and turbine design the simplest and least costly tool for acquiring basic information is the cascade wind tunnel. In essence this consists of a number of airfoils of constant cross section equally spaced in a rectangular slot which is connected to a supply of air. Traverses are made to determine the drag and turning effect of the airfoil cascade. Although it has its limita-




TYPICAL TRAVERSE RECORD

tions in that it provides information primarily only on the two-dimensional performance of the cascade this does give the essential starting point for a compressor or turbine design and, later, when the complete compressor or turbine is tested, it gives a background of information against which the three-dimensional effects may be assessed as deviations from the two-dimensional performance of the individual blade sections.

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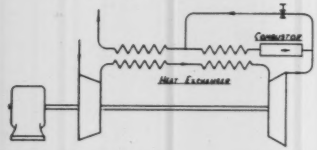
**A Coal-Burning Gas Turbine,** by Donald L. Mordell, Mem. ASME, McGill University, Toronto, Ontario, Canada. 1951 ASME Semi-Annual Meeting paper No. **51—SA-32** (mimeographed).

A SMALL experimental coal-burning gas turbine is now being designed and constructed by the Gas Dynamics Laboratory at McGill University. The cycle on which this is to operate is the exhaust-heated cycle (Trans. ASME, vol. 72, No. 3). Modifications have been introduced to reduce the heat-transfer surface required and to permit easier manufacture.

For the prototype engine, whose design and construction is being financed by the Department of Mines and Technical Surveys, the starting point is a Rolls Royce propeller-turbine engine. This engine has a two-stage centrifugal compresser and two-stage axial turbine. The heat exchangers and furnace being designed will permit the development of some 600 hp. Design features of the heat exchangers, which have to operate at temperatures greater than in conventional units, are discussed.

Various arrangements of the cycle are considered and results are given of a detailed thermodynamic investigation of an arrangement appearing to offer many advantages for an experimental engine. The results include the over-all efficiency and the surface area and bulk of the required heat exchangers.

It is concluded that for relatively small sizes, say, less than 10,000 hp, in circumstances where high utilization can be assured, the exhaust-heated cycle offers many advantages.




EXHAUST-HEATED COAL-BURNING GAS-TURBINE CYCLE WITH TWO HEAT EXCHANGERS

# *Machine Design*

**The Fatigue Strength of Threaded Connections,** by R. C. A. Thurston, Mem. ASME, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Ontario, Canada. 1951 ASME Semi-Annual Meeting paper No. **51—SA-11** (in type; to be published in Trans. ASME).

PUBLISHED information on the strength of threaded connections subjected to dynamic loading has been surveyed and summarized, with particular reference to high-duty applications.

After a consideration of the load distribution and the concentration of stress at the thread roots, the subject is discussed from the following viewpoints: Effect of thread form; effect of method of manufacture; effect of degree of tightness; methods for improving performance; special modifications in design.

In general, the basic principles to be followed in the design of high-strength bolt and stud assemblies are outlined, the reasons underlying them explained, and evidence in their support given when possible.

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**Aircraft Turbosupercharger Bearings—Their History, Design, and Application Technique,** by S. R. Puffer, General Electric Company, West Lynn, Mass. 1951 ASME Semi-Annual Meeting paper No. **51—SA-12** (in type; to be published in Trans. ASME).

THE problems associated with the development of the aircraft turbosupercharger arising from operation at high speeds, high temperatures, and high altitudes, were legion, and many years of intensive effort were spent in obtaining satisfactory solutions. This paper deals primarily with the first of these, high speeds, and is restricted mainly to bearing problems, but of necessity will have to consider to some extent the contingent effect of both high temperatures and high altitudes.

The development of bearings and lubrication methods to solve these problems has benefited not only aviation, but industry in general.

From the small bearings operating at very high speeds, it has not been too great a step to the larger gas-turbine bearings operating at speeds of 8000 to 13,000 rpm. The same general principles apply.

This development has also been of service to the ball-bearing manufacturers, as from it they have learned much about the characteristics and operation of their own bearings. The quality of these bearings has been greatly improved, so that now industry can specify a high-speed bearing application with reasonable assurance that it will function successfully from the first.

Today, many well-known military aircraft such as the Convair B-36, are equipped with turbos built by the author's company. Turbos have been applied to commercial aircraft also. Boeing's "Stratocrusier," now in service with about a half-dozen airlines, has turbosupercharged engines.

Having been through this experience, the author's company, and, it is believed, some others, have set up complete and elaborate bearing test centers, where the characteristics of practically any bearing, under any practical conditions of load, lubrication, vibration, and temperature, can be determined accurately in advance of its actual installation.

## ASME Transactions for August, 1951

THE August, 1951, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

TECHNICAL PAPERS

An Introduction to Arc-Cast Molybdenum and Its Alloys, by J. L. Ham. (50—A-70)

Experience With Austenitic Steels in High-Temperature Service in the Petroleum Industry, by M. E. Holmberg. (50—A-41)

An Investigation of the Role of Aluminum in the Graphitization of Plain Carbon Steel, by A. M. Hall and E. E. Fletcher. (50—A-69)

Nickel-Chromium-Molybdenum Steel Valve Casting After 50,000 Hours of Service at 900 F, by T. N. Armstrong and R. J. Greene. (50—A-67)

The General Tensional Relaxation Properties of a Bolting Steel, by D. N. Frey. (50—A-68)

Basic Factors in Hot-Machining of Metals, by E. J. Krabacher and M. E. Merchant. (50—A-92)

Cutting Temperatures and Metal-Cutting Phenomena, by B. T. Chao and K. J. Trigger. (50—A-43)

Design Features of the Nordberg Radial Engine, by D. I. Bohn and Emil Grieshaber. (50—OGP-1)

Heat Transfer to a Fluid Flowing Turbulently in a Smooth Pipe With Walls at Constant Temperature, by R. A. Seban and T. T. Shimazaki. (50—A-128)

Basic Study for a Generating Station, by G. R. Milne. (50—A-87)

Fireside Deposits on Steam Generators Minimized Through Humidification of Combustion Air, by Paul Murphy, Jr., J. D. Piper, and C. R. Schmansky. (50—A-86)

Developments in Spreader-Firing Wet Wood, by A. S. Weigel.

# COMMENTS ON PAPERS

*Including Letters From Readers on Miscellaneous Subjects*

## Air-Pollution Prevention

COMMENT BY W. G. CHRISTY[1]

This paper[2] is a valuable contribution to the literature on the subject of air pollution.

Milwaukee County, Wis., should be included in the counties mentioned by the author. This county passed an air-pollution ordinance in 1948.

A bill was introduced in the New Jersey Legislature at the 1950 Session empowering any county in the state to create an air-pollution-control authority. The bill failed of adoption but, by a resolution of the Legislature, an Air Pollution Commission was appointed to make an investigation and then make recommendations to the next session of the Legislature.

There has been agitation in the New York metropolitan area for interstate air-pollution regulations. The Richmond County Chapter of the New York State Society of Professional Engineers held a public meeting regarding this last year. They proposed legislation by the States of New York, New Jersey, and Connecticut to create an Interstate Air Pollution Commission. They proposed creating this in a similar manner to the Interstate Sanitary Commission which is engaged in clearing up water pollution in the metropolitan area. Another meeting to discuss this matter further was held in the Borough Hall, Staten Island, only recently.

The Ringelmann chart is used in most communities and is specified in most ordinances, but it has certain limitations. In the writer's opinion there is a need for a new means or method of measuring the shade of smoke. That should be a project for the Air Pollution and Smoke Prevention Association of America or this Society.

The author calls attention to the great progress made in fuel-burning equipment over the past 50 years. Most of us familiar with the problem agree that more progress is needed. As the writer has mentioned often in previous papers and discussions, the human element in air-pollution work is most important. In his opinion it will continue to be so. No matter what improvements are made and no matter how good the equipment, men will still be needed to design, build, operate, and maintain plants and equipment. It will continue to be necessary actively to promote education and to instill air-pollution consciousness into the minds of the public.

The author has brought out a new thought in outlining what he feels is the basic reason for the lag in air-pollution-prevention work; that is, our indifference to or lack of fear of polluted air. The medical profession should establish some much-needed facts about the effects of air pollution. There is too much loose talk on the subject now.

It has always been apparent to the writer that the general public and many municipal and county officials underestimate the magnitude of the job of eliminating air pollution. In too many communities enforcement officers are handicapped by lack of sufficient competent manpower and facilities to do the job.

COMMENT BY H. B. LAMMERS[3]

Concurrence with many of the author's statements was expressed by the speaker in a paper[4] given before the Air Pollution and Smoke Prevention Association of America, Inc., at its 1950 convention in Montreal, in which some of the reasons for failures of city smoke programs were discussed. It is indeed unfortunate that many of the problems recognized a century ago are still with us today. Emphasis in the past has been on legislation, but legislation, no matter how well conceived, has never been nor will it ever be the complete answer to this problem.

Air-pollution programs fail: (*a*) Because cities themselves most frequently refuse to go along with their own program (example, dumps, poor housekeeping, smoke from municipal buildings and institutions); (*b*) continued political interference (example, personnel on the payroll, politically sponsored, who do not have the skill required); (*c*) inability to pay for the necessary professional talent involved (example, smoke inspector cannot receive more than the mayor or other city department heads); (*d*) economic factors are not properly considered; (*e*) lack of basic information as to what is in the air, how much and the effect of each component. Before standards are promulgated, basic information must be available.

It is interesting to note the statement in the Bureau of Mines Bulletin no. 254 (1926), "The direct effect of smoke or any of its attributes, including soot, dust, and gases, in amounts which may ordinarily prevail in the atmosphere of a smoky city, is not shown to be detrimental to persons in normal health," is true today,[5] since no new evidence has been presented to contradict this statement. As a matter of fact the preliminary report on the Donora episode seems to corroborate the conclusion of the Bureau of Mines in the Trail smelter investigation.

The author states the case well under "Developments in Conducting the Work." It is evident that after a half century we have no national standards, that those adopted by many municipalities are not enforced, and the responsibility for their enforcement is nullified by inaction. The Salt Lake City program of 25 years ago recognized lack of a definite or reliable standard of measurement; yet until recently, no sincere effort, to our knowledge, has been made to establish such a standard.

Likewise in discussing the "General Nature of the Problem," the author gives the reasons for the ups and downs of these programs—his reasons are both valid and common experience. The writer is inclined, from his experiences in many cities, to blame failures in most of them to a lack of proper standards of evaluation to gage improvement.

In discussing dust emission and meth-

[1] Director of the Bureau of Smoke Control, New York, N. Y. Mem. ASME.

[2] "Air-Pollution Prevention in the United States," by J. F. Barkley, MECHANICAL ENGINEERING, vol. 73, April, 1951, pp. 284–288.

[3] Chairman and Director of Engineering of the Coal Producers Committee for Smoke Abatement, Cincinnati, Ohio. Mem. ASME.

[4] "Unsolved Problems in Air Pollution Control," by H. B. Lammers, *Combustion*, vol. 22, July, 1950, pp. 46–48.

[5] "Health Aspects of Air Pollution," by A. J. Lanza, *Combustion*, vol. 21, July, 1949, pp. 56–57.

ods for testing, the author is realistic in stating that money is not usually available for making such tests. However, he might have pointed out that in many cities funds have been available, but such funds were spent on parts of the city air-pollution-control program that were ineffective, ill-conceived, but nevertheless written into the law. This indicates the inadvisability of writing any legislation unless conditions are understood, and the public is assured that it will be enforced.

The acceptance of the ASME information bulletin, "Example Section for a Smoke Regulation Ordinance," by cities was made possible in no small degree by its advocacy by the Coal Producers Committee for Smoke Abatement. We consider it only a model, however, and modify it to suit local conditions. In general, the example sections are considered to be practical, economic, and capable of accomplishing good results if administered effectively.

It is to be deplored that losses due to air pollution have not been ascertained with facts as a background, and that figures which are used go unchallenged when obviously they have been taken "out of the air." At best these are "educated guesses" as the author states. Statistical data are in the record that bills for laundry and dry cleaning per family are higher in some cities where practically no coal is burned than in cities where coal is the preponderant fuel used. Los Angeles and St. Louis are, respectively, such cities. The same comparison can be made on the figures for sales of paint, wallpaper, and the like, in the same cities.[6]

In discussing the "History of Ordinances," the author might have said that limitations on hand-fired equipment have been applied for 75 years almost to the exclusion of other types of equipment but we still have much air pollution with us, perhaps more rather than less. This is even true in some cities that have only a small percentage of hand-fired equipment. This has built up the popular belief that only hand-fired equipment is responsible for a city's air pollution and/or that only coal is the offender. We also find cities which burn no solid fuel confronted with a major air-pollution problem. We find cities, with so-called smokeless fuels and anthracite applied to hand-fired equipment, that also have air-pollution problems, and such cities have ordinances and control programs. It doesn't add up! The Coal Producers Committee for Smoke Abatement visited cities in which plant inspections revealed 83 to 90 per cent of the equipment to be mechanized, yet 75 per cent of the plants visited were emitting objectionable smoke! The human element (the personal equation) is an important factor regardless of equipment fired; it is the one requiring more attention if the problem is to be solved.

The author should have included a discussion of the air pollution which comes from incinerators, and the harmful effect of tobacco smoke as a factor in health of people. After all if smoke is injurious, then smoke from tobacco, since it is much more concentrated, is more injurious than that normally found in the atmosphere. Isn't smoke, by its very definition, the same regardless of its source?

A major source of pollution in our large cities results from burning of waste, refuse, garbage, and the like, required by our form of urban civilization. Such installations are numerous, poorly installed and operated, and they add a considerable volume to the total atmospheric pollution. It is extremely difficult to understand why such refuse is permitted to be consumed on crude hand-fired equipment while the same city frequently imposes a penalty on the consumer who uses coal in the same way! Improvements necessary to keep emissions from this type of equipment to a minimum have been too long delayed; this matter should have received consideration in the review.

We question the author's statement that smoke-suppression efforts were pursued with vigor. If they were, it is now evident that the methods were ineffective; certainly 50 years is a long time to wait before decision is reached that the wrong method has been employed. The Coal Producers Committee for Smoke Abatement has demonstrated (model city—Columbus) that a very great deal can be accomplished in a few years using a common-sense approach. In the paper it is pointed out that everything from anthracite to state laws have been specified—apparently common sense, engineering know-how, and administrative skills have been overlooked as the proper remedies.

### AUTHOR'S CLOSURE

The author is indeed appreciative of the comments of Messrs. Christy and Lammers whose opinions he values highly. Their comments improve the coverage of the subject matter.

J. F. BARKLEY.[7]

[6] U. S. Department of Commerce, Bureau of Census, 1939; U. S. Department of Labor, Bureau of Labor Statistics, Bulletin no. 636, 639,641, 1934-1936.

[7] Chief, Fuels Utilization Branch, Bureau of Mines, Washington, D. C. Fellow ASME.

## Silicone Lubricants

COMMENT BY W. A. ZISMAN[8] AND J. E. BROPHY[9]

This[10] paper is a summary of some of the work done on the silicone lubricants in the past 6 years. The new data on the effect of the quantity of silicone grease in a ball bearing is valuable.

In discussing the type G greases, the claim of "long" service in ball bearings operating at temperatures to 400 F is made. This performance at 400 F is not indicated elsewhere in the paper. Amplification of this statement seems worth while.

It would be of interest to know how many runs were averaged to give a life of 5730 hr at 300 F in a bearing. These data were presented as item 2 in Table 6.

Table 6 represents the average life of grease G as 5733 hr. Probably this run is one of those made in the Navy-Industry Cooperative Program. However, the supplemental data bring the average life to approximately 2612 hours at 300 F.

The suggestion of the authors that the maximum amount of silicone grease be used, compatible with the bearing temperature rise, is an interesting one. Earlier work at the Naval Research Laboratory indicates that the time of failure can be postponed by having a sufficient reservoir of fluid to bleed to the bearing, particularly near the end of its life. This bleeding is occasioned by the momentary high temperatures the bearing experiences.

Table 1 should be used with caution, since the column "Useful temperature range" contains no information regarding the useful life of these fluids at the top quoted temperatures. This is particularly important in the case of fluids C and D. For further information on this matter see the paper of Murphy, Saunders and Smith.[11] In addition, the top limit of grease G seems excessive, since the grease becomes "soupy" above 325 F. Much work on high-temperature greases and bearings has been done by an industry-government co-operative committee organized by the Bureau of Ships. This work will be published in 1951.

[8] Head, Lubrication Branch, Chemistry Division, Naval Research Laboratory, Washington, D. C. Mem. ASME.

[9] Engineer, Charge of Design, Naval Research Laboratory, Washington, D. C. Jun. ASME.

[10] "The Properties and Performance of Silicone Lubricants," by G. Grant, 3rd, and C. C. Currie, MECHANICAL ENGINEERING, vol. 73, April, 1951, pp. 311-316.

[11] "Thermal and Oxidation Stability of Polymethylphenylsiloxanes," by C. M. Murphy, C. E. Saunders, and D. C. Smith, *Industrial and Engineering Chemistry*, vol. 42, December, 1950, pp. 2462-2468.

It would be valuable to know more concerning the effect of the silicone lubricant on the rated load of ball bearings. Little is presented in this paper.

It should be remarked that the need for specially heat-treated bearings and their procurement by the Bureau of Ships was in connection with a large program on high-temperature bearings and greases. Evidently, some of the results reported here by the authors are from that program.

Does the paragraph in the "Applications" section, dealing with grease H mean that the carbon-black grease has the ability to eliminate rusting and corrosion in high-temperature corrosive or high-humidity atmospheres? If so, further information would be very useful.

In discussing the operation of bearings in ovens, no bearing temperature is given. Since the oven ambient temperature may be quite different from the bearing temperature, it would seem that part of the long life reported may be due to the bearing temperature being below that of the oven. More complete data would answer this question.

### AUTHORS' CLOSURE

We wish to thank Messrs. Zisman and Brophy for the time and thought they put into the discussion of our paper. We shall try to answer as many of their questions as completely as we can. The answers will be in approximately the same sequence as the questions were asked.

In spite of the fact that grease G may or may not become "soupy" at 325 F, tests do show that long life is possible at 400 F. By long life we mean that bearings lubricated with grease G will operate at least 4 to 10 times longer than they do when lubricated with the best diester or petroleum base greases we have tested. Tests performed in our laboratory and tests conducted by an independent researcher show that 400 F is not excessive. In actual bearing tests a life of 1200 to 1500 hr was obtained with 204 bearings rotating at 3600 rpm at a temperature of 400 F. This life is greater than that obtained with organic greases at 300 F.

In item 2, Table 6, the life of grease G was given as 5730 hr at 300 F. The life should be 4885 hr. This latter value is based upon certain anomalies or peculiarities in test results. Our reasoning in arriving at 4885 hr follows.

The dispersion of data is great, but a definite tendency was noted for runs to be either very short or very long. There were relatively few runs between these extremes. It was noted that when the interference fit on the shaft was greater than 0.00015 in., short life could be expected. In the range of 0.00015 to 0.0000 a transition takes place, and long life can be expected with loose fits. Consequently, the short runs were considered mechanical failures instead of lubricant failures and for lubricant life the longer runs were used. The actual life data and shaft fits are:

| 0.00015 Tight or Tighter | 0.00015 to 0.0000 Tight | 0.0000 to 0.0007 Loose |
|---|---|---|
| 387 hr | 336 hr | 3100 hr |
| 390 | 1940 | 4639 |
| 954 | 6368 | 5433 |
| 1208 | | |

It is apparent that some error crept into the average as presented in the paper because the average of the lubricant life end points is 4885 hr. It is also apparent, however, that the life can be expected to be quite satisfactory if the proper mechanical conditions exist.

Table 1 should have been explained more completely. A top temperature of 500 F is given for fluids C and D on the basis of laboratory-control tests. A 35 gram sample of fluid is placed in a beaker and heated continuously at 500 F until gelation occurs. Fluid C possesses a life of approximately 1000 hr and fluid D a life of 1500 hr or more under these test conditions. Thus, if fluid D were used at 500 F for 8 hours daily, it would not gel for at least 6 months. The authors feel that this is excellent performance for such a high temperature.

The paragraph in the "Applications" section does not mean that grease H has the ability to eliminate rusting under high-temperature corrosive conditions. Grease H, by forming a coating over metal parts, will prevent the entrance of liquids and corrosive solids into the bearing. In this manner, grease H serves as a seal in high-temperature corrosive applications.

The observation that bearings in service may be below oven temperature is, of course, a possibility since data obtained from industrial applications can never be as precise as that obtained in the laboratory. If we accept this premise, we must conclude that the organic lubricants used were also exposed to lower temperatures. This premise, it does not alter the fact that the only lubricant that worked satisfactorily in these cases was grease H. Other lubricants failed because it was too hot for them—grease H did not.

G. GRANT, 3RD.[12]
C. C. CURRIE.[12]

[12] Dow Corning Corporation, Midland, Mich.

## The Present Shortage of Engineers

TO THE EDITOR:

Mr. C. S. L. Robinson's comments, page 437 of the May, 1951, issue of MECHANICAL ENGINEERING, on the present shortage of engineers are generally logical. I am certain, however, that he does not mean to depreciate every "successful engineer . . . . who spends most of his time on office administration, employee relations . . . .," and so on, as his letter seems to indicate.

There are several types of successful engineers. Those without the desire or qualities for leadership may reach the top in the strictly technical branches of their employer's organizations as highly respected members of squads or as individuals. Those with qualities of leadership may be expected to assume charge of the work of others. Another type of successful engineer is one who has been placed in sales, management, or other nontechnical departments, where his background can be used to improve cooperation between technical and nontechnical departments.

Turning again to engineers having qualities of leadership, such men may be literally bursting with good technical ideas. The work that can be accomplished by one man is obviously limited; an outstanding engineer is, therefore given the help of others. In time, this can logically result in further additions to an individual's responsibility, such as administration, employee relations, customer relations, etc.

I cannot believe that Mr. Robinson meant to call this sort of engineering "unprofessional," although I would agree that a very young engineer in the employment department might not be a professional engineer.

One or two other statements in Mr. Robinson's letter may, I hope, provoke further discussion.

SABIN CROCKER, JR.[13]

### COMMENT BY C. S. L. ROBINSON[14]

Thanks are expressed for correcting a possible misinterpretation. The original letter may be summarized as follows: The defense program is the cause of the present shortage of engineers.

Its technical work must be performed by engineers and scientists who have already been educated. These should be given the proper status and assistance.

[13] Assistant Engineer, Shipbuilding Division, Bethlehem Steel Co., Quincy, Mass. Mem. ASME.

[14] West Newton, Mass. Mem. ASME.

# REVIEWS OF BOOKS

*And Notes on Books Received in the Engineering Societies Library*

## Engineering and Western Civilization

ENGINEERING AND WESTERN CIVILIZATION. By James Kip Finch. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Ont., Can.; London, England, 1951. Cloth, 5¾ × 9 in., illus., graphs, tables, bibliography, index, x and 397 pp., $5.

REVIEWED BY S. W. DUDLEY[1]

IN RECENT years most engineers, whether practitioners, teachers, research workers, or administrators, have been too heavily burdened by their immediate tasks to think much about the long-range historical perspective, the observable results, and the emergent trends of what has been called the Engineering and Industrial Age.

Fortunately, James Kip Finch, Renwick professor and dean emeritus of the school of engineering, Columbia University, has had the inclination and found the time to note the interplay of events, the energy and judgment to track down clues —sometimes obscure but always alluring—and the genius to present his conclusions in an attractive and convincing fashion.

Heretofore, books about engineering have dealt largely with the lives and achievements of outstanding figures in that field or with the technological development of a particular period. Since the turn of the century, in addresses and in papers before engineering societies, but rarely in books, there have been voiced, with growing emphasis, the obligations resting upon the engineer, be he student, practitioner, or administrator, to include in his thinking the humanistic, social, and economic implications and consequences of his activities.

Dean Finch speaks for engineers effectively and with contagious enthusiasm. His experience in professional practice, in education, and in administration has been comprehensive.

Out of his accumulated knowledge Dean Finch has sketched the "remarkable evolution, through some 50 centuries or more, of one of the oldest of the practical arts." While avoiding technological details, he has illuminated the interdependence of engineering and western civilization, and has concluded with the optimistic observation that mankind slowly but surely is working its way toward effective co-operation and the "good life for man" envisioned by Aristotle so long ago.

Pertinent, frequently pungent, quotations from the wisdom of the past are liberally sprinkled through the text. They range from Aristotle to David Harum. Dean Finch's purpose is to enlighten, not merely instruct. "Knowledge alone," he concludes, "is not enough. 'Education,' says Professor Whitehead, 'is the acquisition of the art of the utilization of knowledge' " . . . . . and he continues, as reassurance to all of us, disturbed often by the complexities of the present, "It is not a simple, restful world we have to hand on to generations to come. 'Absolute certainty is an illusion,' observed the late Justice Oliver Wendell Holmes, 'repose is not the destiny of man.' "

Dean Finch has surveyed the entire sweep of man's progress. He has viewed the panorama with a new perspective and a sharpened focus. This is a most timely service. It gives us more than a storehouse of wisely selected facts and enlightening experiences. It suggests ways through the new territory ahead. In no other volume has the significance of science and engineering to western civilization been exhibited over such a range of aspects, with such sure grasp of the realities and the implications.

It is an absorbing story. It's insight and vision should go far to strengthen our confidence in the enlightened free spirit of man.

[1] Retired Dean, School of Engineering, Yale University, New Haven, Conn. Hon. Mem. ASME.


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## Engineering Metals

THE BEHAVIOR OF ENGINEERING METALS. By H. W. Gillett. John Wiley and Sons, Inc., New York, N. Y.; Chapman and Hall, Ltd., London, England, 1951. Cloth, 5½ × 9 in., 58 figs., 17 tables, appendix, subject and author indexes, xvi and 395 pp., $6.50.

REVIEWED BY C. L. CLARK[2]

AS STATED by the author, the primary intent of this book is to give the nonmetallurgist sufficient information with respect to metals and alloys so that he will have some knowledge of the materials he is using and thus permit him to make intelligent selections for at least the more common applications. However, the author has actually accomplished much more than this and it is believed that even those who have specialized in metallurgical work could read this book with considerable interest even though it might be considered as "nontechnical" from their viewpoint. This is particularly true since in this day of high specialization, even within narrow fields of engineering, one is apt to concentrate on the "individual tree" and forget the beauty of the "woods."

In reading this book, one must be impressed by Dr. Gillett's intimate knowledge of such a wide range of subjects. He discusses all steels from Bessemer through the so-called "superalloy" analyses, all nonferrous metals and their alloys, as well as the testing methods which have been developed for their evaluation. Furthermore, none of his discussions are of the textbook type or abstracts from the literature. Rather, in his characteristic manner (which can be appreciated by those who had the pleasure of knowing him) he presents his own beliefs and explanations. Likewise, even though he might be classified as primarily a "laboratory" man, he is able to

[2] Metallurgical Engineer, special steel developments, Steel and Tube Division, The Timken Roller Bearing Company, Canton, Ohio. Mem. ASME.

recognize and intelligently discuss the commercial aspects of many of the subjects reviewed. For example, why is not calcium alloyed with lead for storage-battery applications (page 223) and why does Inconel contain 5 to 6 per cent iron (page 234)?

Many, including the reviewer, may not be in agreement with all of the statements made and may tend to criticize the author for presenting only one side of the argument on certain of the debatable subjects. This, of course, is a prerogative of the author and he may have felt that the other procedure would have confused the issue for those for whom this book is primarily intended. However, his procedure may leave the reader with the wrong impression. For example, he severely criticizes the stress-rupture test, page 26, primarily because it is an "overload" test and yet it has been the one most widely used in the evaluation of superalloys and is being given ever-increasing weight by design engineers and the ASME Boiler Code in the selection of allowable working stresses. On the other hand he rates fatigue tests very high even though they could also be classified as overload tests. Likewise, many will question his statement that hardness-test results by themselves mean nothing, page 21.

One must agree with the author that service testing, rather than laboratory testing, is the only true criterion of the suitability of a metal and a design for a given application and this procedure has been followed for many years for critical parts. However, after the service-testing of the component parts has been completed, attempts should be made to correlate the results with certain laboratory tests for control purposes. If all should follow the procedure referred to for selecting heats for electronic tubes, page 50, the entire industrial picture could be disrupted for means would not be available for storing and handling heats while awaiting approval

In a book covering such a broad scope, it naturally follows that little space can be devoted to each of the individual subjects. However, Dr. Gillett has handled the transition from one subject to another so skillfully that one does not have the impression that he is reading a dictionary.

Dr. Gillett, in writing this book at the "twilight" of his career, has made a valuable contribution to the engineering field and it is regrettable that more noted authorities, in their particular field of activity, do not do likewise. Experience and judgment are still two of the most important assets in engineering work and books of this type are invaluable in this respect, especially to the younger engineers.

## Plant Layout

PLANT LAYOUT: Planning and Practice. By R. W. Mallick and A. T. Gaudreau. John Wiley and Sons, Inc., New York, N. Y.; Chapman and Hall, Ltd., London, England, 1951. Cloth, 6 × 9½ in., 212 figs., 25 tables, bibliography, index, xii and 391 pp., $7.50.

REVIEWED BY HENRY A. COZZENS, JR.[3]

WITH the current erection of new plants and the revamping of present plants for war production the subject of this book is receiving deserved attention. Hence it is natural that several books should be written on this subject. Also, the recognition by colleges of the importance of plant layout as a technique in industrial engineering has created a demand for books for classroom use. Some of these books may be the formalized presentation of the notes of the instructor. We may suggest that these books were written by those who have "taught it." Now comes this book which is the product of those who have "done it." The book may well be written for the education of the executive as well as the plant engineer both of whom may have been influenced by the ever-present optimism of the average layout planner.

In this book the authors provoke thought on the cost of a layout, what money will be put back into the safe if it be adopted, is the layout needed at all, should we not subcontract the job to someone better fitted than ourselves for the work. Layout may not be the complete answer, and if it should be, there is a long-drawn-out survey followed by plenty of drawing-board work before the best plan is adopted.

In the treatment of the subject the book deviates from certain subjects found in other texts. For instance, the usual chapter on plant location is omitted. Someone above the layout engineer should think out this one—he starts with site planning. The drawings and illustrations have been contributed by professional, commercial, and industrial enterprises rather than selections from management and engineering periodicals. Much of the material is refreshingly new.

There are four parts to the book: (1) Approach to plant layout, (2) planning the processing departments, (3) designing plant service facilities, and (4) justifying the layout project. The layout of service facilities is given more space than process layout, and deservedly, since attention must be paid to the care and feeding of the line itself.

Because of the crusade to rid ourselves of unnecessary paper work and to improve the efficiency of the clerical worker, the subject of office layout is thoroughly discussed. Thought in this direction should remove some of the whimsy and favoritism which may be prevalent in arranging furniture in the right-sized space in the average office.

Materials handling is well covered although the illustrations could be larger and clearer. The book is replete with forms for analysis and check lists to make sure that the thinking is correct and complete. Because of its practical aspect the book should find wide use in graduate schools. It represents a manual for the professional layout engineer.

[3] Adjunct Professor of Industrial Engineering, New York University, New York, N. Y.

## Sheet-Metal Fabricating

PRINCIPLES AND METHODS OF SHEET-METAL FABRICATING. By George Sachs. Reinhold Publishing Corporation, New York, N. Y., 1951. Cloth, 5¾ × 9 in., figs., bibliography, tables, index, xi and 526 pp., $10.

REVIEWED BY R. L. KENYON[4]

IN THE preface the author indicates the purpose of the book to be an analysis of "the principles of forming operations in such a manner that the experience gained in the forming of certain parts can be applied to the design of the tools and to the development of the blank sizes and contours required for the production of other different-appearing parts."

During World War II the United States Government sponsored considerable research and development work related to forming high-strength aluminum alloys and since then the International Nickel Company has sponsored similar work on austenitic stainless steels. The author has brought together the results of these studies "in several of which he has taken an active part as director." A considerable amount of the material is taken from "Forming of Austenitic Chromium-Nickel Stainless Steels" which was edited by Krivobok and Sachs and published by the International Nickel Co., Inc., 1947. To this the author has added information on carbon steels, aluminum, brass, and other nonferrous metals.

[4] Associate Director of Research, Research Laboratory, Armco Steel Corporation, Middletown, Ohio. Mem. ASME.

The book is divided into five parts: sheet metal and sheet-metal parts, principles of forming various parts, principles of deep drawing, press-die forming of sheet-metal parts, and various sheet-metal forming methods. The various types of fabricating operations are classified very much the same as in the Krivobok-Sachs book just mentioned, with considerable expansion in the treatment as well as the addition of chapters on cartridge-case fabrication, impact extrusion and coining, drop-hammer forming, stretch-forming, roll and draw-bench forming and spinning. The book is copiously illustrated (mostly line drawings) to show blank designs as well as sequence of forming operations on a large number of fabricated parts.

The reviewer cannot refrain from mentioning that in those parts of the book closely read and checked several errors and misstatements of fact were observed, some of which could have been avoided by more careful prepublication review. The following are examples: Top carbon limit for deep-drawing steel is generally considered to be 0.10 rather than 0.15 per cent; method of processing such sheets is not accurately described and rimming steel sheets do *not* have "a rather porous core." The equations for strain on pages 63, 103, and 172 are in error.

The author uses no specific literature references but relies on a general bibliography at the end of each chapter. Author references in captions under illustrations sometimes cannot be identified with the complete reference even when it is given in the bibliography and frequently no references by such authors are listed. The bibliographies have numerous errors in volume, year, and page number of some of the references. Some illustrations (notably figs. I-19 and I-20 on page 30) are not explained sufficiently to be understood.

Some explanations lack clarity; for example, the discussion on page 41 of stretcher strains in mild steel is very confusing. "The annealing operation for rimming steel is generally followed by a flattening operation in the temper roll or by roller leveling, as well as by additional stretcher leveling where very flat sheets are required. The flattening operation must be carried out to a predetermined reduction in thickness in order to eliminate the tendency of low-carbon steel to develop stretcher strains on forming." In the first place flattening is not the sole purpose of this operation—it is done also to cold-work the steel sufficiently to suppress the elongation at the yield point which is associated with stretcher strains. Secondly, stretcher leveling is used for flat stock and rarely for deep-drawing sheets. Thirdly, the amount of cold work necessary to suppress stretcher straining is not critical, as the author implies. It is true that there is a *minimum* amount of cold working required for a given lot of sheets, but there is no *maximum* amount above which stretcher straining will again occur. Finally, the degree of this cold working (usually temper rolling) is so low that thickness reduction cannot be measured accurately enough for control; increase in length is the common method of measurement.

The chapter on cartridge-case fabrication contains many misstatements. The author's statement on page 362, "Many attempts have been made to substitute steel for brass, but they have met only a limited success," must be challenged; brass is now completely inadequate and unsuccessful in modern recoilless weapons because it is not strong enough. The present military program is based on steel cases entirely for this purpose. Many of the fallacious statements on pages 362–363 seem to be based on the somewhat conflicting viewpoints of different branches of the military services during the last war. At present there is no doubt that the Armed Services favor steel cartridge cases because they have been and are being made in large quantities and are performing satisfactorily in present-day weapons.

Although the metallurgical information in the book regarding the various metals is rather sketchy, the cataloging of various types of drawing and forming operations should be helpful to student and metalworker alike.

## Books Received in Library

ANALYSIS OF THE FOUR-BAR LINKAGE, Its Application to the Synthesis of Mechanisms. By J. A. Hrones and G. L. Nelson, published jointly by John Wiley & Sons, Inc., New York, N. Y., and The Technology Press of Massachusetts Institute of Technology, Cambridge, Mass.; Chapman & Hall, Ltd., London, England, 1951. Fabrikoid, $11\frac{1}{2} \times 17\frac{1}{4}$ in., 730 pp., diagrams, charts, $15. This volume is an exhaustive survey of the displacement and velocity characteristics of a four-bar linkage in the range of operation where the driving crank makes a complete revolution while the follower crank oscillates. Over 700 charts represent about 500,000 solutions covering 7000 displacement paths with the velocity given at 72 equal intervals of drive-crank angle along each path. An introductory section is devoted to a general discussion of the four-bar linkage and to an explanation of the use of the charts. The volume is very large, being about double the size of an ordinary book in each dimension.

ASPECTS FONDAMENTAUX DE LA THERMOCINÉTIQUE. (Publications Scientifiques et Techniques du Ministère de l'Air, Notes Techniques No. 41.) Première Partie, Théorie. By P. Vernotte. Au Service de Documentation et d'Information Technique de l'Aéronautique, Paris, France, 1951. Paper, $7 \times 10\frac{1}{2}$ in., 45 pp., tables, 325 fr. The author analyzes the kinetic activity of heat, its means of propagation, its significance in practical use and in the laboratory, and methods of calculation. The technical article is preceded by a long preface by the author discussing the "scientific spirit" and its overemphasis.

BASIC WING AND AIRFOIL THEORY. By A. Pope. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1951. Cloth, $6 \times 9\frac{1}{4}$ in., 294 pp., illus., diagrams, charts, tables, $5. Intended for use by college seniors and first-year graduate students, this book covers the field of wing and airfoil theory at an intermediate level. A knowledge of mathematics usually included in undergraduate engineering courses is assumed, and a review of vector analysis and complex variables is given. Each theory presented is followed by a statement of its limitations and a definition of its applicability to present practice. Latest theories on airfoils and wing designs are included.

CREEP OF METALS. (Physics in Industry.) By L. A. Rotherham. Institute of Physics, London, England, 1951. Linen, $6 \times 9\frac{3}{4}$ in., 80 pp., illus., diagrams, charts, tables, 15 s; $2.25. Of interest to both metallurgists and engineers, this monograph is concerned with the salient characteristics of the physics of creep phenomena in metals. The subjects dealt with are: the characteristics of the creep curves; crystalline flow; metallographic features of creep; grain boundary, transient, steady-state, and tertiary creep; and the development of creep-resistant alloys.

# ASME BOILER CODE

## Interpretations

THE Boiler Code Committee meets monthly, to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meet-

ing June 15, 1951, and approved by the Board August 13, 1951.)

CASE NO. 934-1* (REOPENED)

*(Special Ruling)*

*Inquiry:* Will unfired pressure vessels fabricated by fusion welding under the test requirements of Pars. U-68, U-69 and U-70 meet the Code requirements if the base metal is of copper conforming to Specifications SB-11, 12, 13 SB-42 or of copper conforming to the light cold rolled temper, the hot rolled or hot rolled and annealed tempers of ASTM Specification B-152-50T except that any material covered thereby is obtained in the phosphorus deoxidized condition?

*Reply:* It is the opinion of the Committee that deoxidized copper material conforming to any of the mentioned specifications may be used for the construction of unfired pressure vessels by fusion welding under the general requirements of Pars. U-68, U-69 or U-70. For vessels constructed under any one of these paragraphs, the welding requirements of the paragraph and Section IX of the Code shall apply except that:

(1) One qualification test weld shall be made in the minimum thickness and one in the maximum thickness of material that will be used in construction;

(2) The elongation as determined by the free-bend test shall be not less than 30 per cent for Pars. U-68 and U-69, and not less than 20 per cent for Par. U-70 construction;

(3) Stress-relieving is not required;

(4) The allowable working stresses used in applying the design rules shall be those given in Table U-3 for annealed material.

(5) The joint efficiencies allowed shall be:

(a) For Par. U-68 construction, 90 per cent efficiency;

(b) For Par. U-69 construction, 80 per cent efficiency;

(c) For Par. U-70 construction, the ratio of SE values given in Par. U-70(a) divided by 11,000.

(6) Because the deoxidized copper exhibits no significant loss of impact strength at temperatures as low as —325 F, the impact test requirements of Par. U-142(a) may be omitted for service temperatures of −325 F and above.

(7) All vessels fabricated of this material by fusion welding shall be subject to hammer tests as described in Pars. U-77(b) and (c) of the Code.

* Hereafter a digit following a case number will indicate how many times the case has been reopened.

CASE NO. 1124-1* (REOPENED)

*(Special Ruling)*

*Inquiry:* May the shells of pressure vessels complying with Par. U-69 of the 1949 Section VIII and with Par. UW-52(b) of the 1950 Section VIII be constructed of electric-resistance-welded pipe for which the minimum tensile strength is 75,000 psi, if the thickness is not over 0.58 in. and the diameter is not over 30 in.?

*Reply:* It is the opinion of the Committee that electric-resistance-welded pipe may be used within the limitations given in the Inquiry for shells of pressure vessels if it conforms to Specification SA-135-46T except that the mechanical properties and chemical requirements shall be as follows:

Mechanical Properties:

| | |
|---|---|
| Tensile str., min. psi | 75,000 |
| Yield str., min. psi | 45,000 |
| Elongation in 2 in., min. per cent | 20 |

When the process of manufacture of the pipe does not require crop ends, the flattening test shall be taken from the same pipe as the tensile specimens and the number of tests required shall be the same as the number of tensile tests.

Chemical Requirements:

| | |
|---|---|
| Phosphorus, max. per cent | 0.045 |
| Sulphur, max. per cent | 0.06 |
| Carbon, max. per cent | 0.30 |
| Manganese, per cent | 0.35 to 1.25 |

The allowable stress to be used in Table U-4 of the 1949 Section VIII is 12,750 psi and in Table UG-27 of the 1950 Section VIII is 15,950 psi, both with temperatures not exceeding 650 F.

CASE NO. 1136

*(Special Ruling)*

*Inquiry:* In order to meet Government regulations aiming at the conservation of molybdenum, will it be permissible to use Type 316 stainless steel as furnished to any Code approved specification covering this grade, except that the minimum molybdenum content will be 1.75 per cent?

*Reply:* It is the opinion of the Committee that Type 316 stainless steel furnished to any Code approved specification, except that the minimum molybdenum content will be 1.75 per cent, may be used under the Code rules now covering construction of regular Type 316 steel.

CASE NO. 1138

*Inquiry:* May steel tubes in low-pressure steel heating boilers be installed by furnace brazing to headers and/or tube sheets? Tests to destruction have demonstrated a factor of safety substantially higher than 5.

*Reply:* It is the opinion of the Committee that steel tubes installed in water-tube boilers by furnace brazing may be considered to comply with the requirements of the Low-Pressure Heating Boiler Code under the following conditions:

(1) Tubes and tube sheets or headers shall be low carbon steel conforming to a Code specification.

(2) Brazing material shall be either tough pitch brazing copper or deoxidized copper.

(3) Parts to be brazed shall be fitted to have substantially metal-to-metal contact.

(4) The contacting surfaces shall be completely free of scale, grease, or other foreign material. Surfaces shall be machined if necessary to assure compliance with this requirement.

(5) Surfaces to be joined in a furnace having an air or burned gas atmosphere shall be painted with a suitable liquid flux. No flux is required where the brazing is done in an electrically-heated furnace in which a hydrogen atmosphere is maintained.

(6)(a) The copper brazing metal may be applied as wire, ribbon or granules to one side of the joint only. The finished joint must show complete penetration of copper around the entire circumference of the tube. When the brazing is done in a hydrogen atmosphere, the copper may be electro-deposited on one or both surfaces to be joined.

(b) If the design does not permit visual inspection of both sides of the joint after brazing, then a full size unit shall be constructed and the joints sectioned to demonstrate that the procedure will produce joints meeting the necessary requirements. The authorized inspector shall satisfy himself that the brazing practiced during the manufacture corresponds properly with the practice established for test samples. He may, at any time, require the manufacturer to demonstrate the adequacy of the brazing practice.

(7) For water tubes brazed into a header, the thickness of the header shall be at least 0.1 times the outside diameter of the tubes and in no case less than the minimum tube thickness permitted in Table H-3. For water tubes brazed into a tube sheet the thickness of the tube sheet should not be less than 0.1 times the tube diameter and in no case less than the minimum thickness specified in Table H-1 for the boiler shell.

# Proposed Revisions and Addenda to Boiler Construction Code

AS need arises, the Boiler Code Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennally the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code. Simple changes are indicated directly. In the more involved revisions added words are printed in SMALL CAPITALS; deleted words are enclosed in brackets [].

Comments should be addressed to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.

### Power Boilers 1949

PAR. P-332(d)(1) In the second sentence after "by a manufacturer," insert "or an assembler."

PAR. P-332(a)(3) At end of paragraph add:

in which case Form P-4 will be sufficient.

### Material Specifications 1949

EDITORIAL NOTE

The Boiler Code Committee has approved the addition to Section II as new specifications, SB-241-50T, Specification for Aluminum-Alloy Pipe, and SB-247-50T, Specification for Aluminum-Alloy Die Forgings. In Tables 1 and 2 of the latter specification, however, only the alloys 990A, CS41A, GS11A, GS11B, and M1A will be used. These new specifications will be incorporated in the 1952 edition of Material Specifications. Meantime those in need of them may secure copies from ASTM.

### Unfired Pressure Vessels, 1950

PAR. UG-6(c) Revise to read:

(c) Steel plate conforming to ASTM Specifications A-7-50T Steel for Bridges and Buildings, A-113-50T (Grade C) Structural Steel for Locomotives and Cars, and A-283-50T (Grades A, B, C, and D) Low and Intermediate Tensile Strength Carbon Steel Plates of Structural Quality, may be used for pressure parts in unfired pressure vessels provided all the following requirements are met:

(1) The vessels are not used to contain lethal substances, either liquid or gaseous;

(2) The material is not used in the construction of unfired steam boilers [See Par. U-2(f)];

(3) The design temperature at which the material is used is between —20 F and 650 F;

(4) The thickness of plates on which strength welding is applied does not exceed $^5/_8$ in.;

(5) The steel is manufactured by the electric-furnace or open-hearth process.

PAR. UG-24(a) In first line change "70" to "80."

PAR. UG-24(b) Delete. Reletter remaining paragraphs.

PAR. UG-24(g) In last line change "70" to "80."

PAR. UA-402 Beginning in third line delete "an additional casting where an 80 per cent quality factor is used and any number of." In next to last line delete "an 80 or" and substitute "a."

PAR. UA-403 In second line delete "exceeding 70 per cent (up to 80 or 90 per cent)" and substitute "of 90 per cent."

TABLE UG-23 Delete and substitute the accompanying Table UG-23.

TABLE UHA-23 The accompanying Table UHA-23 is an advance printing of one that will appear in the forthcoming Part UHA General Requirements for all Pressure Vessels of High Alloy Steels.

## Table UG-23 Maximum Allowable Stress Values in Tension for Carbon and Low Alloy Steel in Pounds per Square Inch

| Material and Specification Number | Grade | Spec. Min. Tensile | Notes | FOR METAL TEMPERATURES NOT EXCEEDING DEG F: -20 to 650 | 700 | 750 | 800 | 850 | 900 | 950 | 1000 | 1050 | 1100 | 1150 | 1200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PLATE STEELS** | | | | | | | | | | | | | | | |
| **Carbon Steels** | | | | | | | | | | | | | | | |
| ASTM-A-7-50T | - | 60000 | (1)(3) | 13800 | - | - | - | - | - | - | - | - | - | - | - |
| SA-30 | Flange | 55000 | (2) | 13750 | 13250 | 12050 | 10200 | 8350 | - | - | - | - | - | - | - |
| SA-30 | Firebox A | 55000 | (4) | 13750 | 13250 | 12050 | 10200 | 8350 | 6500 | - | - | - | - | - | - |
| SA-30 | Firebox D | 48000 | (4) | 12000 | 11650 | 10700 | 9300 | 7900 | 6500 | - | - | - | - | - | - |
| ASTM-A-113-50T | C | 48000 | (1)(3) | 11050 | - | - | - | - | - | - | - | - | - | - | - |
| SA-129 | A,B,C | 44000 | - - | 11000 | - | - | - | - | - | - | - | - | - | - | - |
| SA-201 | A | 55000 | - - | 13750 | 13250 | 12050 | 10200 | 8350 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-201 | B | 60000 | - - | 15000 | 14350 | 12950 | 10800 | 8650 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-212 | A | 65000 | - - | 16250 | 15500 | 13850 | 11400 | 8950 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-212 | B | 70000 | - - | 17500 | 16600 | 14750 | 12000 | 9250 | 6500 | 4500 | 2500 | - | - | - | - |
| ASTM-A-283-50T | A | 45000 | (1)(3) | 10350 | - | - | - | - | - | - | - | - | - | - | - |
| ASTM-A-283-50T | B | 50000 | (1)(3) | 11500 | - | - | - | - | - | - | - | - | - | - | - |
| ASTM-A-283-50T | C | 55000 | (1)(3) | 12650 | - | - | - | - | - | - | - | - | - | - | - |
| ASTM-A-283-50T | D | 60000 | (1)(3) | 13800 | - | - | - | - | - | - | - | - | - | - | - |
| SA-285 | A | 45000 | (2)(4) | 11250 | 11000 | 10250 | 9000 | 7750 | 6500 | - | - | - | - | - | - |
| SA-285 | B | 50000 | (2)(4) | 12500 | 12100 | 11150 | 9600 | 8050 | 6500 | - | - | - | - | - | - |
| SA-285 | C | 55000 | (2)(4) | 13750 | 13250 | 12050 | 10200 | 8350 | 6500 | - | - | - | - | - | - |
| SA-299 | - | 75000 | (9) | 18750 | 17700 | 15650 | 12600 | 9550 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-300 | - | - | (14) | - | - | - | - | - | - | - | - | - | - | - | - |
| **Low Alloy Steels** | | | | | | | | | | | | | | | |
| SA-202 | A | 75000 | - - | 18750 | 17700 | 15650 | 12600 | 9550 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-202 | B | 85000 | - - | 21250 | 19800 | 17700 | 12800 | 9900 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-203 | A,D | 65000 | - - | 16250 | 15500 | 13850 | 11400 | 8950 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-203 | B,E | 70000 | - - | 17500 | 16600 | 14750 | 12000 | 9250 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-203 | C | 75000 | - - | 18750 | 17700 | 15650 | 12600 | 9550 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-294 | A | 65000 | - - | 16250 | 16250 | 16250 | 15650 | 14400 | 12500 | 10000 | 6250 | - | - | - | - |
| SA-204 | B | 70000 | - - | 17500 | 17500 | 17500 | 16900 | 15000 | 12750 | 10000 | 6250 | - | - | - | - |
| SA-204 | C | 75000 | - - | 18750 | 18750 | 18750 | 18000 | 15900 | 13000 | 10000 | 6250 | - | - | - | - |
| SA-225 | A | 70000 | (13) | 17500 | 17500 | 17500 | - | - | - | - | - | - | - | - | - |
| SA-225 | B | 75000 | (13) | 18750 | 18750 | 18750 | - | - | - | - | - | - | - | - | - |
| SA-301 | - | 65000 | - - | 16250 | 16250 | 16250 | 15650 | 14400 | 12500 | 10000 | 6250 | - | - | - | - |
| SA-302 | A | 75000 | - - | 18750 | 18750 | 18750 | 18000 | 15900 | 13000 | 10000 | 6250 | - | - | - | - |
| SA-302 | B | 80000 | - - | 20000 | 20000 | 20000 | 19100 | 16800 | 13250 | 10000 | 6250 | - | - | - | - |

*(Continued on page 761)*

# Table UG-23 Maximum Allowable Stress Values in Tension for Carbon and Low Alloy Steel in Pounds per Square Inch (*Continued*)

| Material and Specification Number | Grade | Spec. Min. Tensile | Notes | FOR METAL TEMPERATURES NOT EXCEEDING DEG F | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | -20 to 650 | 700 | 750 | 800 | 850 | 900 | 950 | 1000 | 1050 | 1100 | 1150 | 1200 |
| **PIPES & TUBES** | | | | | | | | | | | | | | | |
| **Seamless Carbon Steels** | | | | | | | | | | | | | | | |
| SA-53 | A | 48000 | (4)(6) | 12000 | 11650 | 10700 | 9300 | 7900 | 6500 | - | - | - | - | - | - |
| SA-53 | B | 60000 | (4)(6) | 15000 | 14350 | 12950 | 10800 | 8650 | 6500 | - | - | - | - | - | - |
| SA-83 | A | - | (4)(6) | 11750 | 11450 | 10550 | 9200 | 7850 | 6500 | - | - | - | - | - | - |
| SA-106 | A | 48000 | - - | 12000 | 11650 | 10700 | 9300 | 7900 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-106 | B | 60000 | - - | 15000 | 14350 | 12950 | 10800 | 8650 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-192 | - | - | - - | 11750 | 11450 | 10550 | 9200 | 7850 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-210 | - | 60000 | - - | 15000 | 14350 | 12950 | 10800 | 8650 | 6500 | 4500 | 2500 | - | - | - | - |
| **Seamless Low Alloy Steels** | | | | | | | | | | | | | | | |
| SA-158 | P3a | 60000 | - - | 15000 | 15000 | 15000 | 15000 | 14400 | 13100 | 11000 | 7800 | 5500 | 4000 | 2500 | 1200 |
| SA-158 | P3b | 60000 | - - | 15000 | 15000 | 15000 | 14700 | 14000 | 12500 | 10000 | 6200 | 4200 | 2750 | 1750 | 1200 |
| SA-158 | P5a | 60000 | (15) | - | 13400 | 13100 | 12800 | 12400 | 11500 | 10000 | 7300 | 5200 | 3300 | 2200 | 1500 |
| SA-158 | P5b | 60000 | (15) | - | 13400 | 13100 | 12800 | 12400 | 10900 | 9000 | 5500 | 3500 | 2800 | 1800 | 1200 |
| SA-158 | P5c | 60000 | (15) | - | 13400 | 13100 | 12800 | 12400 | 11500 | 10000 | 7300 | 4800 | 4000 | 1800 | 1200 |
| SA-158 | P11 | 60000 | - - | 15000 | 15000 | 15000 | 15000 | 14400 | 13100 | 11000 | 7800 | 5500 | 4000 | 2500 | 1200 |
| SA-158 | P15 | 60000 | - - | 15000 | 15000 | 15000 | 14400 | 13750 | 12500 | 10000 | 6250 | - | - | - | - |
| SA-158 | P16 | 60000 | (15) | - | 13400 | 13100 | 12500 | 11500 | 9500 | 7000 | 5000 | 3500 | 2500 | 1800 | 1200 |
| SA-158 | P17 | 60000 | (15) | - | 13400 | 13100 | 12800 | 12500 | 12000 | 10800 | 8500 | 5500 | 3300 | 2200 | 1500 |
| SA-206 | P1 | 55000 | - - | 13750 | 13750 | 13750 | 13450 | 13150 | 12500 | 10000 | 6250 | - | - | - | - |
| SA-209 | T1 | 55000 | - - | 13750 | 13750 | 13750 | 13450 | 13150 | 12500 | 10000 | 6250 | - | - | - | - |
| SA-209 | T1a | 60000 | - - | 15000 | 15000 | 15000 | 14400 | 13150 | 12500 | 10000 | 6250 | - | - | - | - |
| SA-209 | T1b | 53000 | - - | 13250 | 13250 | 13250 | 13000 | 12750 | 12500 | 10000 | 6250 | - | - | - | - |
| SA-213 | T3 | 60000 | - - | 15000 | 15000 | 15000 | 15000 | 14400 | 13100 | 11000 | 7800 | 5500 | 4000 | 2500 | 1200 |
| SA-213 | T5 | 60000 | (15) | - | 13400 | 13100 | 12800 | 12400 | 11500 | 10000 | 7300 | 5200 | 3300 | 2200 | 1500 |
| SA-213 | T7 | 60000 | (15) | - | 13400 | 13100 | 12500 | 11500 | 9500 | 7000 | 5000 | 3500 | 2500 | 1800 | 1200 |
| SA-213 | T9 | 60000 | (15) | - | 13400 | 13100 | 12800 | 12500 | 12000 | 10800 | 8500 | 5500 | 3300 | 2200 | 1500 |
| SA-213 | T11 | 60000 | - - | 15000 | 15000 | 15000 | 15000 | 14400 | 13100 | 11000 | 7800 | 5500 | 4000 | 2500 | 1200 |
| SA-213 | T12 | 60000 | - - | 15000 | 15000 | 15000 | 14750 | 14200 | 13100 | 11000 | 7500 | 5000 | 2800 | 1550 | 1000 |
| SA-213 | T13 | 60000 | (15) | - | 13400 | 13100 | 12800 | 12400 | 10900 | 9000 | 5500 | 3500 | 2500 | 1800 | 1200 |
| SA-213 | T14 | 60000 | - | 15000 | 15000 | 15000 | 14700 | 14000 | 12500 | 10000 | 6200 | 4200 | 2750 | 1750 | 1200 |
| SA-213 | T16 | 60000 | (15) | - | 13400 | 13100 | 12800 | 12400 | 11500 | 10000 | 7300 | 4800 | 2800 | 1800 | 1200 |
| SA-213 | T17 | 60000 | (5) | 15000 | - | - | - | - | - | - | - | - | - | - | - |
| SA-213 | T21 | 30000 | - - | 15000 | 14800 | 14500 | 13900 | 13200 | 12000 | 9000 | 7000 | 5500 | 4000 | 2700 | 1500 |
| SA-213 | T22 | 60000 | - - | 15000 | 15000 | 15000 | 15000 | 14400 | 13100 | 11000 | 7800 | 5800 | 4200 | 3000 | 2000 |
| SA-280 | - | 55000 | - - | 13750 | 13750 | 13750 | 13450 | 13150 | 12500 | 10000 | 6250 | - | - | - | - |
| SA-315 | - | 60000 | - - | 15000 | 15000 | 15000 | 14750 | 14200 | 13100 | 11000 | 7500 | 5000 | 2800 | 1550 | 1000 |
| **FORGINGS** | | | | | | | | | | | | | | | |
| **Carbon Steels** | | | | | | | | | | | | | | | |
| SA-105 | I | 60000 | (4) | 15000 | 14350 | 12590 | 10800 | 8650 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-105 | II | 70000 | (4) | 17500 | 16600 | 14750 | 12000 | 9250 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-181 | I | 60000 | (4) | 15000 | 14350 | 12950 | 10800 | 8650 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-181 | II | 70000 | (4) | 17500 | 16600 | 14750 | 12000 | 9250 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-266 | I | 60000 | - - | 15000 | 14350 | 12950 | 10800 | 8650 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-266 | II | 70000 | - - | 17500 | 16600 | 14750 | 12000 | 9250 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-266 | III | 75000 | - - | 18750 | 17700 | 15650 | 12600 | 9550 | 6500 | 4500 | 2500 | - | - | - | - |
| **Low Alloy Steels** | | | | | | | | | | | | | | | |
| SA-182 | F1 | 70000 | - - | 17500 | 17500 | 17500 | 16900 | 15000 | 12750 | 10000 | 6250 | - | - | - | - |
| SA-182 | F2 | 70000 | (15) | - | 16150 | 15500 | 15000 | 14400 | 13100 | 11000 | 7800 | 5500 | 4000 | 2500 | 1200 |
| SA-182 | F5 | 90000 | (15) | - | 17500 | 16000 | 14500 | 13000 | 11500 | 10000 | 7300 | 5200 | 3300 | 2200 | 1500 |
| SA-182 | F22 | 70000 | - - | 17500 | 17500 | 17500 | 17500 | 16000 | 14000 | 11000 | 7800 | 5800 | 4200 | 3000 | 2000 |
| **CASTINGS** | | | | | | | | | | | | | | | |
| **Carbon Steels** | | | | | | | | | | | | | | | |
| SA-27 | 60-30 | 60000 | (7)(8) | 15000 | 14350 | 12950 | 10800 | 8650 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-27 | 65-35 | 65000 | (7)(8) | 16250 | 15500 | 13850 | 11400 | 8950 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-27 | 70-36 | 70000 | (7)(8) | 17500 | 16600 | 14750 | 12000 | 9250 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-95 | | 70000 | (8) | 17500 | 16600 | 14750 | 12000 | 9250 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-216 | WCA | 60000 | (8) | 15000 | 14350 | 12950 | 19800 | 8650 | 6500 | 4500 | 2500 | - | - | - | - |
| SA-216 | WCB | 70000 | (8) | 17500 | 16600 | 14750 | 12000 | 9250 | 6500 | 4500 | 2500 | - | - | - | - |
| **Low Alloy Steels** | | | | | | | | | | | | | | | |
| SA-217 | WC1 | 65000 | (8)(9) | 16250 | 16250 | 16250 | 15650 | 14400 | 12500 | 10000 | 6250 | - | - | - | - |
| SA-217 | WC4 | 70000 | (8)(9) | 17500 | 17500 | 17500 | 17000 | 15800 | 14000 | 10000 | 6250 | - | - | - | - |
| SA-217 | WC5 | 70000 | (8)(9) | 17500 | 17500 | 17500 | 17000 | 15800 | 14000 | 11000 | 7800 | 5500 | 4000 | - | - |
| SA-217 | WC6 | 70000 | (8)(9) | 17500 | 17500 | 17500 | 17000 | 15800 | 14000 | 11000 | 7800 | 5500 | 4000 | - | - |
| SA-217 | WC9 | 70000 | (8)(9) | 17500 | 17500 | 17500 | 17000 | 15800 | 14000 | 11000 | 7800 | 5800 | 4200 | 3000 | 2000 |
| SA-217 | C5 | 90000 | (8)(9) | 21600 | 21600 | 20400 | 19000 | 17000 | 13600 | 10000 | 7300 | 5200 | 3300 | 2200 | 1500 |
| SA-217 | C12 | 90000 | (8)(9) | 22000 | 22000 | 21000 | 19400 | 17300 | 15000 | 11750 | 8500 | 5500 | 3300 | 2200 | 1500 |
| **BOLTING** | | | | | | | | | | | | | | | |
| **Carbon Steels** | | | | | | | | | | | | | | | |
| SA-261 | BO | 100000 | (10)(11) | 16250 | 14950 | 12500 | 10000 | 6875 | - | - | - | - | - | - | - |
| SA-307 | B | 55000 | (12) | * | | | | | | | | | | | |
| **Alloy Steels** | | | | | | | | | | | | | | | |
| SA-193 | BA | - | (10)(11) | 16250 | 14950 | 13650 | - | - | - | - | - | - | - | - | - |
| SA-193 | BB | - | (10)(11) | 18750 | 17200 | 15650 | - | - | - | - | - | - | - | - | - |
| SA-193 | BC | - | (10)(11) | 20000 | 18400 | 16750 | - | - | - | - | - | - | - | - | - |
| SA-193 | B5 | - | (10)(11) | 20000 | 20000 | 20000 | 20000 | 17250 | 13750 | 10300 | 7300 | 4800 | 2750 | - | - |
| SA-193 | B7 | - | (10)(11) | 20000 | 20000 | 20000 | 20000 | 16250 | 12500 | - | - | - | - | - | - |
| SA-193 | B7a | - | (10)(11) | 20000 | 20000 | 20000 | 20000 | 17250 | 13750 | 10300 | 7300 | 4800 | 2750 | - | - |
| SA-193 | B14 | - | (10)(11) | 20000 | 20000 | 20000 | 20000 | 18750 | 16650 | 14250 | 11000 | 6250 | 2750 | - | - |
| SA-193 | B16 | - | (10)(11) | 20000 | 20000 | 20000 | 20000 | 18750 | 16650 | 14250 | 11000 | 6250 | 2750 | - | - |

NOTES: The stress values in this table may be interpolated to determine values for intermediate temperatures.

(1) See Par. UG-6.
(2) Flange quality in this specification not permitted over 850F.
(3) These stress values are one-fourth the specified minimum tensile strength multiplied by a quality factor of 0.92.
(4) For service temperatures above 850F it is recommended that killed steels containing not less than 0.10% residual silicon be used. Killed steels which have been deoxidized with large amounts of aluminum and rimmed steels may have creep and stress-rupture properties in the temperature range above 850F, which are somewhat less than those on which the values in the above table are based.
(5) Between temperatures of 650F and 1000F, inclusive, the stress values for Specification SA-201, Grade B, may be used until high temperature test data become available.
(6) Only (silicon) killed steel shall be used above 900F.
(7) Sections over 2 inches in thickness not permitted for pressure parts.
(8) To these stress values a quality factor as specified in Par. UG-24 shall be applied.
(9) These stress values apply to normalized and drawn material only.
(10) These stress values are established from a consideration of strength only and will be satisfactory for average service. For bolted joints, where freedom from leakage over a long period of time without retightening is required, lower stress values may be necessary as determined from the relative flexibility of the flange and bolts, and corresponding relaxation properties.
(11) Between temperatures of -20 to 400F, stress values equal to the lower of the following will be permitted: 20% of the tensile strength, or 25% of the yield strength.
(12) Not permitted above 450F; allowable stress value 7000 psi.
(13) Between temperatures of 750F to 1000F, inclusive, the stress values for Specification SA-212, Grade B, may be used until high temperature test data become available.
(14) The stress values to be used for temperatures below -20F when steels are made to conform with Specification SA-300 shall be those that are given in the column for -20 to 650F.
(15) Maximum allowable stress values for temperatures below 700F. (*See top left of next page.*)

## Table UHA-23 Maximum Allowable Stress Values

| Material and Specification Number | Grade | Type | Spec. Min. Tensile | Notes | FOR METAL TEMPERATURES NOT EXCEEDING DEG F: -20 to 100 | 200 | 300 | 400 | 500 | 600 | 650 | 700 | 750 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PLATE STEELS** | | | | | | | | | | | | | |
| SA-167 | 3 | 304 | 75000 | (1)(2) | 18750 | 17000 | 16000 | 15450 | 15100 | 14900 | 14850 | 14800 | 14700 |
| SA-167 | 3 | 304 | 75000 | (2) | 18750 | 16650 | 15000 | 13650 | 12500 | 11600 | 11200 | 10800 | 10400 |
| SA-167 | 5 | 321 | 75000 | | 18750 | 18750 | 17000 | 15800 | 15200 | 14900 | 14850 | 14800 | 14700 |
| SA-167 | 6 | 347 | 75000 | | 18750 | 18750 | 17000 | 15800 | 15200 | 14900 | 14850 | 14800 | 14700 |
| SA-167 | 8 | 309 | 75000 | | 18750 | 18750 | 17300 | 16700 | 16600 | 16500 | 16450 | 16400 | 16200 |
| SA-167 | 10 | 310 | 75000 | (3) | 18750 | 18750 | 18500 | 18200 | 17700 | 17200 | 16900 | 16600 | 16250 |
| SA-167 | 10 | 310 | 75000 | (4) | 18750 | 18750 | 18500 | 18200 | 17700 | 17200 | 16900 | 16600 | 16250 |
| SA-167 | 11 | 316 | 75000 | (2) | 18750 | 18750 | 17900 | 17500 | 17200 | 17100 | 17050 | 17000 | 16900 |
| SA-240 | A | 410 | 65000 | | 16250 | 15600 | 15100 | 14600 | 14150 | 13850 | 13700 | 13400 | 13100 |
| SA-240 | C | 347 | 75000 | | 18750 | 18750 | 17000 | 15800 | 15200 | 14900 | 14850 | 14800 | 14700 |
| SA-240 | D | 430 | 70000 | | 17500 | 17500 | 16300 | 15650 | 15100 | 14600 | 14300 | 13900 | 13500 |
| SA-240 | M | 316 | 75000 | (2) | 18750 | 18750 | 17900 | 17500 | 17200 | 17100 | 17050 | 17000 | 16900 |
| SA-240 | S | 304 | 75000 | (1)(2) | 18750 | 17000 | 16000 | 15450 | 15100 | 14900 | 14850 | 14800 | 14700 |
| SA-240 | S | 304 | 75000 | (2) | 18750 | 16650 | 15000 | 13650 | 12500 | 11600 | 11200 | 10800 | 10400 |
| SA-240 | T | 321 | 75000 | | 18750 | 18750 | 17000 | 15800 | 15200 | 14900 | 14850 | 14800 | 14700 |
| **PIPES & TUBES** | | | | | | | | | | | | | |
| **Seamless** | | | | | | | | | | | | | |
| SA-158 | P8a | TP304 | 75000 | (1)(2) | 18750 | 17000 | 16000 | 15450 | 15100 | 14900 | 14850 | 14800 | 14700 |
| SA-158 | P8a | TP304 | 75000 | (2) | 18750 | 16650 | 15000 | 13650 | 12500 | 11600 | 11200 | 10800 | 10400 |
| SA-158 | P8b | TP321 | 75000 | | 18750 | 18750 | 17000 | 15800 | 15200 | 14900 | 14850 | 14800 | 14700 |
| SA-158 | P8c | TP347 | 75000 | | 18750 | 18750 | 17000 | 15800 | 15200 | 14900 | 14850 | 14800 | 14700 |
| SA-213 | TP304 | — | 75000 | (1)(2) | 18750 | 17000 | 16000 | 15450 | 15100 | 14900 | 14850 | 14800 | 14700 |
| SA-213 | TP304 | — | 75000 | (2) | 18750 | 16650 | 15000 | 13650 | 12500 | 11600 | 11200 | 10800 | 10400 |
| SA-213 | TP321 | — | 75000 | | 18750 | 18750 | 17000 | 15800 | 15200 | 14900 | 14850 | 14800 | 14700 |
| SA-213 | TP347 | — | 75000 | | 18750 | 18750 | 17000 | 15800 | 15200 | 14900 | 14850 | 14800 | 14700 |
| SA-213 | TP316 | — | 75000 | (2) | 18750 | 18750 | 17900 | 17500 | 17200 | 17100 | 17050 | 17000 | 16900 |
| SA-213 | TP310 | — | 75000 | (3) | 18750 | 18750 | 18500 | 18200 | 17700 | 17200 | 16900 | 16600 | 16250 |
| SA-213 | TP310 | — | 75000 | (4) | 18750 | 18750 | 18500 | 18200 | 17700 | 17200 | 16900 | 16600 | 16250 |
| **Welded** | | | | | | | | | | | | | |
| SA-249 | TP304 | — | 75000 | (1)(2)(5) | 16000 | 14450 | 13600 | 13150 | 12800 | 12700 | 12650 | 12600 | 12500 |
| SA-249 | TP304 | — | 75000 | (2)(5) | 16000 | 14150 | 12750 | 11600 | 10600 | 9850 | 9500 | 9200 | 8850 |
| SA-249 | TP321 | — | 75000 | (5) | 16000 | 16000 | 14450 | 13400 | 12900 | 12700 | 12650 | 12600 | 12500 |
| SA-249 | TP347 | — | 75000 | (5) | 16000 | 16000 | 14450 | 13400 | 12900 | 12700 | 12650 | 12600 | 12500 |
| SA-249 | TP316 | — | 75000 | (2)(5) | 16000 | 16000 | 15200 | 14900 | 14600 | 14550 | 14500 | 14450 | 14350 |
| SA-249 | TP317 | — | 75000 | (5) | 16000 | 16000 | 15200 | 14900 | 14600 | 14550 | 14500 | 14450 | 14350 |
| **Forgings** | | | | | | | | | | | | | |
| SA-182 | F6 | 410 | 85000 | | 21250 | 20400 | 19750 | 19000 | 18500 | 18100 | 17900 | 17500 | 17050 |
| SA-182 | F8 | 304 | 75000 | (1)(2) | 18750 | 17000 | 16000 | 15450 | 15100 | 14900 | 14850 | 14800 | 14700 |
| SA-182 | F8 | 304 | 75000 | (2) | 18750 | 16650 | 15000 | 13650 | 12500 | 11600 | 11200 | 10800 | 10400 |
| SA-182 | F8t | 321 | 75000 | | 18750 | 18750 | 17000 | 15800 | 15200 | 14900 | 14850 | 14800 | 14700 |
| SA-182 | F8c | 347 | 75000 | | 18750 | 18750 | 17000 | 15800 | 15200 | 14900 | 14850 | 14800 | 14700 |
| SA-182 | F8m | 316 | 75000 | (2) | 18750 | 18750 | 17900 | 17500 | 17200 | 17100 | 17050 | 17000 | 16900 |
| SA-182 | F25 | 310 | 95000 | | 23750 | 23750 | 27750 | 23200 | 22400 | 21500 | 20850 | 20000 | 18500 |
| **Bolting** | | | | | | | | | | | | | |
| SA-193 | B6 | 410 | — | (6) | | | | | | | | | |
| SA-193 | B8 | 304 | 75000 | (2)(6) | | | | | | | | | |

NOTES:
(1) These stress values are allowed when distortion can be permitted without endangering the safety of the structure.

(2) No allowance has been made for corrosive action in the stress values given. Carbide precipitation in service is also to be expected at temperatures above 750F.

(3) These stress values at temperatures of 1050F and above should be used only when assurance is provided that the steel has a predominant grain size not finer than ASTM No. 6.

*(Continuation of note 15 top of page 762)*

For metal temperatures not exceeding deg F

| Spec. | Grade | -20 to 400 | 500 | 600 | 650 |
|---|---|---|---|---|---|
| SA-158 | P5a | 15000 | 14500 | 14000 | 13700 |
| SA-158 | P5b | 15000 | 14500 | 14000 | 13700 |
| SA-158 | P5c | 15000 | 14500 | 14000 | 13700 |
| SA-158 | P16 | 15000 | 14500 | 14000 | 13700 |
| SA-158 | P17 | 15000 | 14500 | 14000 | 13700 |
| SA-213 | T5 | 15000 | 14500 | 14000 | 13700 |
| SA-213 | T7 | 15000 | 14500 | 14000 | 13700 |
| SA-213 | T9 | 15000 | 14500 | 14000 | 13700 |
| SA-213 | T16 | 15000 | 14500 | 14000 | 13700 |
| SA-213 | T13 | 15000 | 14500 | 14000 | 13700 |
| SA-182 | F2 | 17500 | 17500 | 17500 | 16800 |
| SA-182 | F5 | 22500 | 21600 | 20100 | 19000 |

For the basis of selecting stress values see Appendix P (Par. UA-500) of the ASME Boiler Construction Code, Section VIII, 1950 Edition.

## Errata

In the August, 1951, issue of MECHANICAL ENGINEERING in Appendix 2 to the Revisions of the Boiler Construction Code, the following errors in figures should be corrected:

Under the Recommended Stresses for Tables P-5 and P-7 in Power Boiler Code for Alloy Steels, in the third from the last line, for Specification 158 P5C and Specification 213 T14, the last figure (under 1200 deg) should be changed from "1500" to "1200."

Under Austenitic Alloys, in the last line, for 16 Cr 13 Ni 3 Mo material, the value under 950 deg should be changed from "13,850" to "15,100"; the value under 1000 deg from "13,500" to "14,000," and the value under 1050 deg from "13,100" to "12,200."

## for High Alloy Materials in Pounds per Square Inch

| FOR METAL TEMPERATURES NOT EXCEEDING DEG F | | | | | | | | | | | | | | | Material and Specification Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 800 | 850 | 900 | 950 | 1000 | 1050 | 1100 | 1150 | 1200 | 1250 | 1300 | 1350 | 1400 | 1450 | 1500 | |
| | | | | | | | | | | | | | | | **PLATE STEELS** |
| 14550 | 14300 | 14000 | 13400 | 12500 | 10000 | 7500 | 5750 | 4500 | 3250 | 2450 | 1800 | 1400 | 1000 | 750 | SA-167 |
| 10000 | 9700 | 9400 | 9100 | 8800 | 8500 | 7500 | 5750 | 4500 | 3250 | 2450 | 1800 | 1400 | 1000 | 750 | SA-167 |
| 14550 | 14300 | 14100 | 13850 | 13500 | 13100 | 12500 | 8000 | 5000 | 3600 | 2700 | 2000 | 1550 | 1200 | 1000 | SA-167 |
| 14550 | 14300 | 14100 | 13850 | 13500 | 13100 | 12500 | 8000 | 5000 | 3600 | 2700 | 2000 | 1550 | 1200 | 1000 | SA-167 |
| 15700 | 14900 | 13800 | 12500 | 10500 | 8500 | 6500 | 5000 | 3800 | 2900 | 2300 | 1750 | 1300 | 900 | 750 | SA-167 |
| 15700 | 14900 | 13800 | 12500 | 11000 | 9750 | 8500 | 7250 | 6000 | 4750 | 3500 | 2350 | 1600 | 1100 | 750 | SA-167 |
| 15700 | 14900 | 13800 | 12500 | 11000 | 7100 | 5000 | 3600 | 2500 | 1450 | 750 | 450 | 350 | 250 | 200 | SA-167 |
| 16750 | 16500 | 16000 | 15100 | 14000 | 12200 | 12400 | 8500 | 6800 | 5300 | 4000 | 3000 | 2350 | 1850 | 1500 | SA-167 |
| 12750 | 12100 | 11000 | 8800 | 6400 | 4400 | 2900 | 1750 | 1000 | — | — | — | — | — | — | SA-240 |
| 14550 | 14300 | 14100 | 13850 | 13500 | 13100 | 12500 | 8000 | 5000 | 3600 | 2700 | 2000 | 1550 | 1200 | 1000 | SA-240 |
| 13100 | 12500 | 11700 | 9200 | 6500 | 4500 | 3200 | 2400 | 1750 | — | — | — | — | — | — | SA-240 |
| 16750 | 16500 | 16000 | 15100 | 14000 | 12200 | 10400 | 8500 | 6800 | 5300 | 4000 | 3000 | 2350 | 1850 | 1500 | SA-240 |
| 14550 | 14300 | 14000 | 13400 | 12500 | 10000 | 7500 | 5750 | 4500 | 3250 | 2450 | 1800 | 1400 | 1000 | 750 | SA-240 |
| 10000 | 9700 | 9400 | 9100 | 8800 | 8500 | 7500 | 5750 | 4500 | 3250 | 2450 | 1800 | 1400 | 1000 | 750 | SA-240 |
| 14550 | 14300 | 14100 | 13850 | 13500 | 13100 | 12500 | 8000 | 5000 | 3600 | 2700 | 2000 | 1550 | 1200 | 1000 | SA-240 |
| | | | | | | | | | | | | | | | **PIPES & TUBES** |
| | | | | | | | | | | | | | | | **Seamless** |
| 14550 | 14300 | 14000 | 13400 | 12500 | 10000 | 7500 | 5750 | 4500 | 3250 | 2450 | 1800 | 1400 | 1000 | 750 | SA-158 |
| 10000 | 9700 | 9400 | 9100 | 8800 | 8500 | 7500 | 5750 | 4500 | 3250 | 2450 | 1800 | 1400 | 1000 | 750 | SA-158 |
| 14550 | 14300 | 14100 | 13850 | 13500 | 13100 | 12500 | 8000 | 5000 | 3600 | 2700 | 2000 | 1550 | 1200 | 1000 | SA-158 |
| 14550 | 14300 | 14100 | 13850 | 13500 | 13100 | 12500 | 8000 | 5000 | 3600 | 2700 | 2000 | 1550 | 1200 | 1000 | SA-158 |
| 14550 | 14300 | 14000 | 13400 | 12500 | 10000 | 7500 | 5750 | 4500 | 3250 | 2450 | 1800 | 1400 | 1000 | 750 | SA-213 |
| 10000 | 9700 | 9400 | 9100 | 8800 | 8500 | 7500 | 5750 | 4500 | 3250 | 2450 | 1800 | 1400 | 1000 | 750 | SA-213 |
| 14550 | 14300 | 14100 | 13850 | 13500 | 13100 | 12500 | 8000 | 5000 | 3600 | 2700 | 2000 | 1550 | 1200 | 1000 | SA-213 |
| 14550 | 14300 | 14100 | 13850 | 13500 | 13100 | 12500 | 8000 | 5000 | 3600 | 2700 | 2000 | 1550 | 1200 | 1000 | SA-213 |
| 16750 | 16500 | 16000 | 15100 | 14000 | 12200 | 10400 | 8500 | 6800 | 5300 | 4000 | 3000 | 2350 | 1850 | 1500 | SA-213 |
| 15700 | 14900 | 13800 | 12500 | 11000 | 9750 | 8500 | 7250 | 6000 | 4750 | 3500 | 2350 | 1600 | 1100 | 750 | SA-213 |
| 15700 | 14900 | 13800 | 12500 | 11000 | 7100 | 5000 | 3600 | 2500 | 1450 | 750 | 450 | 350 | 250 | 200 | SA-213 |
| | | | | | | | | | | | | | | | **Welded** |
| 12400 | 12150 | 11900 | 11400 | 10600 | 8500 | 6400 | 4900 | 3800 | 2750 | 2100 | 1550 | 1200 | 850 | 650 | SA-249 |
| 8500 | 8250 | 8000 | 7750 | 7500 | 7200 | 6400 | 4900 | 3800 | 2750 | 2100 | 1550 | 1200 | 850 | 650 | SA-249 |
| 12350 | 12150 | 12000 | 11800 | 11500 | 11100 | 10600 | 6800 | 4250 | 3050 | 2300 | 1700 | 1300 | 1000 | 850 | SA-249 |
| 12350 | 12150 | 12000 | 11800 | 11500 | 11100 | 10600 | 6800 | 4250 | 3050 | 2300 | 1700 | 1300 | 1000 | 850 | SA-249 |
| 14250 | 14000 | 13600 | 12800 | 11900 | 10400 | 8850 | 7200 | 5800 | 4500 | 3400 | 2550 | 2000 | 1550 | 1300 | SA-249 |
| 14250 | 14000 | 13600 | 12800 | 11900 | 10400 | 8850 | 7200 | 5800 | 4500 | 3400 | 2550 | 2000 | 1550 | 1300 | SA-249 |
| 16300 | 14000 | 11000 | 8800 | 6400 | 4400 | 2900 | 1750 | 1000 | — | — | — | — | — | — | SA-182 |
| 14550 | 14300 | 14000 | 13400 | 12500 | 10000 | 7500 | 5750 | 4500 | 3250 | 2450 | 1800 | 1400 | 1000 | 750 | SA-182 |
| 10000 | 9700 | 9400 | 9100 | 8800 | 8500 | 7500 | 5750 | 4500 | 3250 | 2450 | 1800 | 1400 | 1000 | 750 | SA-182 |
| 14550 | 14300 | 14100 | 13850 | 13500 | 13100 | 12500 | 8000 | 5000 | 3600 | 2700 | 2000 | 1550 | 1200 | 1000 | SA-182 |
| 14550 | 14300 | 14100 | 13850 | 13500 | 13100 | 12500 | 8000 | 5000 | 3600 | 2700 | 2000 | 1550 | 1200 | 1000 | SA-182 |
| 16750 | 16500 | 16000 | 15100 | 14000 | 12200 | 10400 | 8500 | 6800 | 5300 | 4000 | 3000 | 2350 | 1850 | 1500 | SA-182 |
| 17000 | 15500 | 14000 | 12500 | 11000 | 9750 | 8500 | 7250 | 6000 | 4750 | 3500 | 2350 | 1600 | 1100 | 750 | SA-182 |
| | | | | | | | | | | | | | | | **Bolting** |
| | | | | | | | | | | | | | | | SA-193 |
| | | | | | | | | | | | | | | | SA-193 |

**NOTES:** *(Continued)*

**(4) These stress values shall be considered basic values to be used when no effort is made to control or check the grain size of the steel.**

**(5) These stress values are the basic values multiplied by a joint efficiency factor of 0.85.**

**(6) These stress values are established from a consideration of strength only and will be satisfactory for average service. For bolted joints where freedom from leakage over a long period of time without retightening is required, lower stress values may be necessary as determined from the flexibility of the flange and bolts and corresponding relaxation properties.**

# THE ENGINEERING PROFESSION

*News and Notes*

As Compiled and Edited by A. F. Bochenek

## 1300 Attend Ninth International Management Congress in July

### *São Paulo, Brazil, Selected for Next Congress in 1954*

On July 5, 1951, in the presence of His Royal Highness, the Prince Royal, who twelve days later was crowned King Baudouin of Belgium, the Ninth International Management Congress was opened with suitable ceremonies by Mr. Max-Léo Gérard, Honorary Secretary to the King, a former Minister of Finance and President of the Congress.

More than 1300 delegates from 26 nations participated in the Congress. The largest delegation was from Belgium with Great Britain in second place. The United States was third, followed closely by The Netherlands, with Italy, France, and Sweden next in order. A large part of the U.S.A. delegation traveled to Brussels on the S.S. *Mauretania* and enjoyed preliminary discussions in a series of well-planned sessions on board the ship.

In the opening ceremonies Mr. Paul Ghilian, president of the Belgian National Committee for Scientific Management, and Mr. Assar Gabrielsson of Sweden, president of the International Committee of Scientific Management, spoke briefly. The address of the occasion was delivered by the Honorable William L. Batt, Hon. Mem. ASME, Minister-in-Charge of the ECA Mission to the United Kingdom and former president of the International Committee of Scientific Management. Dr. Batt's subject was "Productivity, the Test of Management Today," and he uttered an eloquent plea for the setting aside of all artificial barriers to greater productivity without which modern civilization may fall.

#### New Discussion Plan Proves Successful

The discussion program was well planned and presented. Twelve topics had been selected two years in advance of the Congress and responsibility for surveying developments under each topic was assigned to one national group. Other countries could contribute to any topic by collaborating with the reporting country.

This plan resulted in 12 comprehensive documents representing the distilled thoughts of 642 individuals residing in 16 countries that hold membership in the International Committee on Scientific Management.

At each session the report was presented by a representative of the reporting country. Discussion was in charge of a discussion leader who addressed questions submitted to him in writing to a panel made up of representatives of all countries which participated in the consolidated report.

The plan resulted in a series of sessions of great interest to the audience, the only difficulty being the lack of time to deal adequately with the questions raised. Of considerable aid were the summary reports which had been printed in advance and were available to Congress participants. It is hoped individual reports will be published by the originating countries and made available in translation.

#### Discussion Topics

The topics of the reports and the names of the reporting countries were:

(1) Structure of large enterprises—Great Britain.

(2) Working methods and personal effectiveness of top managers—Sweden.

(3) Work measurement—USA. Harold B. Maynard, Mem. ASME, president, Methods Engineering Council, Pittsburgh, Pa., served as rapporteur. D. B. Porter, Mem. ASME, department of administrative engineering, New York University, New York, N. Y., was discussion leader.

(4) Recent developments in quality control—Great Britain.

(5) The establishment of a sense of common purpose between management and employees—France.

(6) Job evaluation—Switzerland.

(7) Tested procedures for reducing unit costs of distribution—Belgium.

(8) The flexible and the variable budget—The Netherlands.

(9) Home design for simplified household routines—Norway.

(10) Fundamentals in effective farm management—Brazil.

(11) Advance procedures in public administration—USA. Rapporteur for the session was Herbert Emmerich, director, Public Administration Clearing House, Chicago, Ill.

(12) Education for management—USA. L. A. Appley, Assoc. ASME, and president, American Management Association, New York, N. Y., was rapporteur. Erwin H. Schell, Mem. ASME, chairman, department of business and engineering administration, Massachusetts Institute of Technology, Cambridge, Mass., handled the discussion.

As an additional feature, USA took the responsibility for selecting and presenting a series of six motion-picture films on work simplification contributed by France, Great Britain, and USA. All of the films showed clearly the savings possible through work simplification, but the USA films had additional interest in that they revealed efforts to show workmen and foremen what they might contribute to the economy of an undertaking by suggesting and carrying out work-simplification projects.

The USA Committee in charge of the film program was headed by Serge A. Birn, Mem. ASME, consulting management engineer, Louisville, Ky. Mr. Birn was rapporteur during the showing. Professor Porter served as chairman.

Appraisal of the over-all value of the discussion program is difficult, if not impossible, for a single individual observer. Some of the topics have appeared on previous Congress programs but the manner of presentation at Brussels revealed a wide cross section of interest and knowledge about all the topics even among the less industrialized countries. Nevertheless the traditions and thought patterns of each nation were apparent in the presentation and discussion of all the topics. From many points of view the freshest subjects and the ones that indicate future interest and study were education for management, the structure of large enterprises, and the personal effectiveness of top managers.

#### Education for Management

In particular the report on education for management, which represented the work of over 1000 individuals and companies in 70 countries, attracted a large amount of attention and some sentences from its conclusion are worth quoting.

"Education for management today is making tangible contributions to the betterment of our industrial society and has taken its place among what are regarded as the established practices of good management. More than half the countries of the world have made positive efforts toward education for management. Systematic "on-the-job" training is found in all countries studied. Moreover, an increasingly large number of firms have organized training departments to prepare college graduates and other carefully selected candidates for higher positions, and to operate various other programs of executive development.

"But only a fraction of the need has been met.

"Our present knowledge of what makes for sound judgment, intuition, and other indefinable qualities of good management still leaves much to be desired.

"Management skills must be more clearly

identified and understood. Standards for educational programs and methods of presentation need to be improved. Our terminology must be made more uniform. More and more emphasis needs to be placed upon service rather than success without labor.

The report closed with a quotation by Sir Charles Renold, chairman, British Institute of Management, who observed, "Provisions for teaching about management are now extensive and ideas in regard to the other part of the problem, training in management, are beginning to crystallize."

### International Friendships Strengthened

As in all Congresses, the opportunity for informal discussions across national lines is an important by-product and the splendid facilities offered by the Belgian Committee lent themselves well to this informal interchange.

The social high light of the Congress was the banquet on July 7 held at the Palais du Centenaire. In this ceremonial building, suitably decorated for the occasion, Mr. Gérard, president of the Congress, presided over a program of addresses by Mr. Gabrielsson and Mr. Joseph Pholien, the Premier of Belgium. The Premier paid tribute to the importance of management skills in industry and in government in securing economy and productivity for a peaceful world.

At the closing ceremony on July 11, Mr. Albert De Smaele, Mem. ASME, former Minister of Economic Affairs of Belgium, gave a general report of the work of the Congress. Dr. Th. Limperg of The Netherlands, vice-president of the International Committee, then presented the International Committee Medal to Lieut. Col. L. Urwick of Great Britain, for his contributions to the practical applications, to the theory, and to the philosophy of scientific management. Colonel Urwick responded in an eloquent tribute to the leaders in management. Mr. Gabrielsson then reported on the activities of the International Committee since the Congress in Stockholm in 1947. These included the adoption of new operating rules and the admission of Australia, South Africa, Canada, Austria, and Italy to the International Committee. Mr. Gabrielsson also announced the decision of the Committee to hold the next Congress in Sao Paulo, Brazil, in February, 1954, and the selection of the following officers to serve until the next Congress: *President*, M. Louis Cornil, Belgium; *Deputy Presidents*, Mr. H. B. Maynard, Mem. ASME, USA; Mr. M. E. Alvaro, Brazil; Mr. Rene de Valliere, Switzerland.

After speeches of appreciation in French by M. Louis Ferrasson of France and in English by Mr. Malcome Moore of Australia, Mr. Gérard, president of the Congress, brought it to a close.

All of the participants in the Congress were deeply grateful to the Belgian Committee for the splendid setting for the meeting in the Palais des Beaux Arts; for the fine program of trips to points of industrial, historical, and scientific interest; and for the general spirit of hospitality which pervaded the Congress. In particular, the usually troublesome translation problem in the two languages of the Congress, French and English, was solved by the securing of competent interpreters and by providing reliable radio receivers with ear phones, a set for each listener, which enabled the listener to select his language as broadcast from a transmitter in each meeting room.

### United States Participation

Participation of USA was arranged by the National Management Council, a body representative of eight societies in the United States, including The American Society of Mechanical Engineers. ASME was represented at the Congress by L. A. Appley, S. A. Birn, Daniel M. Braum, Donald F. Carpenter, Harold V. Coes, C. E. Davies, Robert M Gates, Frederick M. Feiker, Dr. L. M. Gilbreth, Harold B. Maynard, Lester C. Morrow, David B. Porter, Erwin H. Schell, Harold F. Smiddy, and J. E. Walters. Mr. Smiddy, who is vice-president of the National Management Council, was chairman of the USA delegation and Erwin H. Schell was chairman of the USA program committee for the Brussels Congress and in charge of the discussion program on the SS *Mauretania*.

It is inevitable that the Brussels Congress will be compared with the two preceding Congresses. In 1938 in Washington, D. C., the country was recovering from a deep depression and the effects of the doctrine of a limited economy. There were tensions between nations and rumors of war. People from outside the USA were not sure that the USA possessed the secret of industrial leadership that had been displayed in the twenties. Whether the 1938 Congress was useful or not is lost in the flow of events that followed in World War II.

The Stockholm Congress in 1947 found the countries of the world trying desperately to rebuild and looking to USA with its newly demonstrated production strength for advice and help. Stockholm was a success because the setting and the spirit were right. So Brussels was a success, its spirit and its setting were right, but more, the participants came with their contributions of experience and knowledge and joined as equals in the interchange.

C.E.D.

# National Manpower Convocation Called by EJC for Pittsburgh, Pa.

## *Stephen Foster Memorial Hall, University of Pittsburgh, Sept. 28, 1951*

A CONVOCATION of engineers, educators, and industrialists to discuss what must be done to maintain and increase the national supply of engineers needed for civilian economy and the Armed Forces has been called by the Engineering Manpower Commission of the Engineers Joint Council, Carey H. Brown, Mem. ASME, chairman of the Commission, announced recently. Invitations have been mailed to 500 key men concerned with engineering and scientific manpower to meet in Stephen Foster Memorial Hall, on the campus of the University of Pittsburgh, Pittsburgh, Pa., Sept. 28, 1951.

Co-operating in the convocation is the Engineers Society of Western Pennsylvania, whose officers are in charge of local arrangements and whose president, G. A. Shoemaker, will preside at the all-day session. Mr. Shoemaker is president of the Pittsburgh Coal Company.

Pittsburgh was chosen for the convocation, Mr. Brown said, because of its proximity to major industrial centers.

To check the impending shortage of engineers, the Commission has developed a program to aid in maintaining the flow of qualified young men to engineering colleges and to aid in promoting optimum utilization of graduate engineers in industry and in the Armed Forces. The purpose of the convocation, Mr. Brown said, is to acquaint educators and industrial leaders with the work of the Commission and of the part each can play in forwarding these programs in their localities. The delegates to the convocation, it is hoped, will serve as representatives of the Commission in receiving and distributing future information, and as local leaders in carrying out future activities.

Delegates will be supplied with a brochure containing copies of all formal speeches and other useful information on the manpower situation. It is hoped this information will be used by delegates to organize manpower meetings in their own communities. Such meetings would help to disseminate the ideas and techniques developed by the EJC.

### Manpower Authorities to Speak

A. C. Monteith, Mem. ASME, vice-president, Westinghouse Electric Company, Pittsburgh, Pa., will open the convocation with a discussion of the acute need for informing citizens about what the engineer actually does to maintain his job and personal safety. Mr. Monteith has served on the Engineering Science Committee, one of the six Scientific Advisory Committees appointed by General Lewis B. Hershey, director of the Selective Service System. As chairman of the Committee on Professional Training of the Engineers' Council for Professional Development, Mr. Monteith helped to develop a comprehensive program of guidance to cover the first five years of a graduate engineer's career.

The second speaker will be S. C. Hollister, Mem. ASME, dean, College of Engineering, Cornell University, Ithaca, N. Y. He will cover what it takes to provide a minimum satisfactory flow of engineering students. Dean Hollister is president of the American Society for Engineering Education and has long been active on the ASEE manpower committees. He is also a member of the Committee on Specialized Personnel in the Manpower Division of the Office of Defense Mobilization.

M. H. Trytten, director, office of scientific

personnel of National Research Council, will tell the delegates about the functions and interrelationship of the various government agencies and committees whose decisions have an effect on the technical manpower situation. As general chairmen of the six Scientific Advisory Committees to General Hershey, Dr. Trytten knows intimately the official mind of Washington.

As the final speaker, Mr. Brown, chairman of EMC, and manager of Engineering and Manufacturing Services at Eastman Kodak Company's Kodak Park Works in Rochester, will explain the programs of the Commission and how these aim to solve the problems raised by the preceding speakers. He will also explain the specific role that members of industry, the technical societies, and the schools can play in implementing the programs of EMC.

### Wide Representation Sought

Following a luncheon which will be arranged for the convenience of delegates in the nearby Hotel Schenley Park, the convocation will resume in the afternoon when the speakers and several other authorities will act as a panel to answer questions.

According to T. A. Marshall, Jr., Mem. ASME, executive secretary of the EMC, the capacity of the Stephen Foster Memorial Hall will limit the number who can participate in the convocation. He urged local sections of engineering societies to co-operate fully in organizing a delegation to represent their areas. Such local groups that have not heard from EMC about the convocation and who wish to send a delegation to Pittsburgh, can arrange for invitations by writing to the EJC Engineering Manpower Commission, 29 West 39th Street, New York 18, N. Y.

MISS BEATRICE HICKS, VICE-PRESIDENT AND CHIEF ENGINEER OF NEWARK CONTROLS COMPANY, BLOOMFIELD, N. J., WAS RE-ELECTED PRESIDENT OF THE SOCIETY OF WOMEN ENGINEERS FOR 1951–1952 AT A RECENT MEETING AT GILFORD PARK, N. J.

# People

## Dr. H. W. Craver Dies, Library Pioneer

HARRISON WARWICK CRAVER, retired director of the Engineering Societies Library, one of the world's finest technical libraries, and former president of the American Library Association died July 27, 1951, at his home in Baltimore, Md.

A native of Owaneco, Ill., Dr. Craver was graduated from Rose Polytechnic Institute and served as an industrial chemist for several years. Deciding that his real interest in technology lay in its literature, he joined the Carnegie Library in Pittsburgh, Pa., in 1900 and there organized the first technology department of any public library.

From 1908 to 1917 he served as director of the Carnegie Library and its library school, and then became director of the Engineering Societies Library. During the next 29 years, Dr. Craver built the library from several individual collections into a unified organization serving the four Founder Societies. He resigned in 1946 because of failing health.

* * *

G. GEOFFREY SMITH, foreign associate, ASME Gas Turbine Power Division, died June 29, 1951, at his home at Radlett, Hertsfordshire, England. He had been a director of Iliffe and Sons, Ltd., of a number of its subsidiary companies. He was appointed a director of Associated Iliffe Press, the parent company, in 1945. He was among the earliest, apart from the few technicians directly involved, to recognize the potentialities of jet propulsion.

## Aeronautics Award Honors Sikorsky

IGOR IVAN SIKORSKY has been awarded the 1951 Daniel Guggenheim Medal and certificate for his contributions to aeronautics. Formal presentation of the medal will be made at the SAE national aeronautics meeting to be held at the Biltmore Hotel, Los Angeles, Calif., Oct. 5, 1951.

Dr. Sikorsky is honored for his development of the helicopter which was instrumental in bringing about such spectacular and humanitarian deeds as rescues at sea, reaching into places not approachable by other means of transportation to carry out injured persons, and making possible taxi service to and from otherwise inaccessible places.

IGOR IVAN SIKORSKY, 1951 WINNER OF THE DANIEL GUGGENHEIM MEDAL

## E. G. Bailey Receives John Fritz Medal for 1952

E. G. BAILEY, Fellow and past-president ASME, and vice-president of Babcock and Wilcox Company, was selected by the John Fritz Medal Board of Award to receive the 1952 John Fritz Medal and Certificate "for outstanding engineering achievements in the field of combustion and distinguished service to his fellows in advancing the engineering profession." The medal will be presented to Mr. Bailey during the ASME Annual Meeting in November.

* * *

HAROLD G. BOWEN, Vice-Admiral, U.S.N., retired, Hon. Mem. ASME, was recently elected a member of The Foundation for the Study of Cycles, New York, N. Y., a non-profit, scientific research organization.

* * *

MARTIN A. MASON, Mem. ASME, chief engineer of the U. S. Army's Beach Erosion Board, has been named dean of the School of Engineering, The George Washington University, Washington, D. C.

## Meetings of Other Societies

**Sept. 17–19**
American Institute of Chemical Engineers, national meeting, Sheraton Hotel, Rochester, N. Y.

**Oct. 1–4**
Association of Iron and Steel Engineers, annual meeting, Sherman Hotel, Chicago, Ill.

**Oct. 8–12**
National Safety Council, 39th national safety council and exposition, Stevens Hotel, Chicago, Ill.

**Oct. 13–14**
American Society for Metals, annual seminar, Hotel Statler, Detroit, Mich.

**Oct. 15–19**
The 33rd Annual Metal Show and 1951 National Metal Congress and Exposition, Detroit, Mich. Exhibits: Michigan State Fair Grounds. Sponsors' headquarters: American Society for Metals, Statler; American Welding Society, Book-Cadillac; Metals Branch, American Institute of Mining and Metallurgical Engineers, Detroit-Leland; and Society for Non-Destructive Testing, Statler.

*(For ASME Calendar of Coming Events see page 771)*

# ASME NEWS

## Record Program Taking Shape for 1951 ASME Annual Meeting

### *Headquarters: Chalfonte-Haddon Hall, Nov. 26–30, 1951*

A REVIEW of the program taking shape for the 1951 Annual Meeting of The American Society of Mechanical Engineers to be held at the Chalfonte-Haddon Hall, Nov. 26–30, 1951, turns up plenty of evidence that engineers in the ASME are more active than ever before in the life of the Society.

The record program of papers of last year will be exceeded by 10 per cent if accommodations within the hotel can be arranged for all the Professional Divisions and committees who want to participate in the program.

The fund of new information scheduled for discussion before ASME audiences is a reflection of how well the Society mirrors the nation's accelerated engineering progress. With unprecedented sums of government money available, answers are being uncovered to questions which otherwise might have impeded the national economy and even the national defense. Research and development work by industry, carried on in laboratories which are the envy of the world, is also adding variety and quality to ASME programs. But new knowledge does not make a completely rounded program in itself. What is further required is a spirit of professional service which encourages engineers to add to the common stock-in-trade of a profession.

The size and wealth of the ASME 1951 program is but one of many signs that American industry, as it expends more of its income in the search of new and better methods and products, is also becoming more willing to share with others the lessons of its experiences and research.

In addition to wealth of material and spirit of service, the 1951 program implies sufficient manpower to carry out an accelerated industrial program. During the recent postwar years, graduating classes have been as high as five times the prewar norm. In the past five years, the ASME has felt the impact of this surge of graduates in a membership that has nearly doubled. In the ASME as in industry and other professional societies, more young men have eagerly sought responsible participation in engineering projects.

The percentage of young men in the profession has heightened the responsibility for leadership of those in high places. Awareness of this responsibility among ASME leaders is apparent in the support of the National Junior Committee, in the presence at ASME national meetings and Division conferences of eminent engineers from whom young men can learn and with whom they can converse, and in the lecture programs and special events arranged to bring to recent graduates the inspiration and guidance of men of attainment.

#### The Need to Attend

Charged as the 1951 Annual Meeting will be with benefits to all members, it will not achieve its full purpose unless members attend its sessions.

One observer, noting the high percentage of engineering leaders participating in the discussion at a recent ASME technical session, regretted that more young men were not present to see and hear the men whom they must necessarily emulate and succeed.

To read an engineering paper and a discussion months after the event is good, but it is no match for the inspiration and the understanding that sound and sight convey. In Atlantic City in November, there will be opportunity to meet and talk with many of the men who are setting the pace in engineering today.

#### More Than 90 Sessions Planned

The following 34 Professional Divisions and Committees of the Society are planning to sponsor more than 90 sessions at the annual meeting: Aviation, Applied Mechanics, Fuels, Gas Turbine Power, Heat Transfer, Hydraulic, Industrial Instruments and Regulators, Machine Design, Management, Materials Handling, Metals Engineering, Oil and Gas Power, Petroleum, Power, Process Industries, Production Engineering, Railroad, Rubber and Plastics, Textile, Wood Industries, Education, Junior Committee, Boiler Feedwater Studies, Cutting Fluids, Effect of Temperature, Fluid Meters, Furnace Performance Factors, High Temperature Steam Generation, Lubrication, Metal Cutting Data, Plastic Flow Metals, Safety, and Vessels Under Pressure. The American Rocket Society will also sponsor sessions at the meeting.

MRS. FRANK W. MILLER, (*center, rear*) NATIONAL PRESIDENT OF THE WOMAN'S AUXILIARY TO THE ASME, IS SERVING ON THE COMMITTEE PLANNING THE WOMEN'S PROGRAM AT THE ANNUAL MEETING. MRS. ROBERT W. WORLEY (*front, left*) IS CHAIRMAN OF THE ARRANGEMENTS COMMITTEE. OTHER MEMBERS ARE MRS. GEORGE S. GETHEN (*rear, left*); MRS. ALLEN W. THORSON, (*rear, right*); AND MISS DORIS SEARS OF THE HEADQUARTERS HOTEL STAFF (*front, right*).

SOME OF THE MEMBERS OF THE ANNUAL MEETING ARRANGEMENTS COMMITTEE OF THE PHILADELPHIA SECTION WHO MET AT ATLANTIC CITY, N. J., JULY 14, 1951, TO PLAN FOR THE FIRST NON-NEW YORK ANNUAL MEETING SINCE 1947.

(*Left to right, front row:* L. R. Gaty, W. F. Thompson, A. W. Thorson, J. K. Louden, Ernest Hartford, Frank W. Miller. *Back row:* O. B. Schier, II, C. B. Campbell, C. M. Hagan, G. S. Gethen, G. H. Auth, B. F. Keene, H. D. Moll, B. W. Webb, E. Sooy, J. Quaid.)

The full tentative program will appear in the October issue of MECHANICAL ENGINEERING thereby giving members plenty of time to review the papers to be presented by the Professional Divisions and activities in which they are interested and to plan to be in Atlantic City during the last week in November.

In addition to the technical program a series of social events and special lectures are planned which will take full advantage of the excellent facilities of the headquarters hotel. Particulars about these events will be announced in the October issue.

### Junior Committee

The National Junior Committee will sponsor a conference at which an eminent engineer will discuss a topic under the general theme, "A Current Plan for Young Engineers." The conference will be the fourth in a series devoted to professional development. For a report on the Junior conference held at the Semi-Annual Meeting, see page 774 of this issue.

### Science Theater

Taking advantage of the excellent theater facilities available at the headquarters hotel, W. F. Coles, Jr., chairman of the Science Theater Committee, has assembled a program of industrial and scientific films, most of which are in color, for the enjoyment of those who would like to visit the plants and view the operations of some of the nation's finest industries in armchair comfort.

The program includes 49 films running from 11 to 45 minutes each. These include the Bureau of Mines' film "Alloy Steels," Westinghouse Electric Corporation's "The Banshee - Jet Propulsion," Babcock and Wilcox Company's "Development of Steam," and The Link Belt Company's "Handling Materials in the Steel Industry."

### Women's Program

As part of the annual meeting the Woman's Auxiliary of the Philadelphia Section has arranged a special program of entertainment for the wives of members. This will include a lecture, a bridge party and a tea dance. As usual the Woman's Auxiliary will hold its annual business meeting and annual luncheon.

## Special ASME Car For Fall Meeting

THE Pullman Company will reserve a car for ASME members on the *Afternoon Hiawatha* of the Milwaukee Road. The train leaves Chicago at 1:00 p.m. Central Standard Time and is due in Minneapolis, Minn., at 7:45 p.m.

The ASME car will be car no. 1012 on the train leaving Chicago, Ill., Sunday, Sept. 23, and also on the train leaving Monday, Sept. 24.

If your railroad agent has any difficulty getting space in these cars, please advise The Secretary, ASME, 29 West 39th Street, New York 18, N. Y. By using these cars you will be among ASME members en route to the Meeting.

# Three Major ASME Meetings Scheduled for September

ONE national and two divisional conferences scheduled for September will launch the 1951–1952 season of ASME meetings.

After the interlude of summer, September traditionally has been the month when the ASME program begins to build up to the annual meeting which is the high light of the Society's program.

### Fall Meeting

The 1951 Fall Meeting will be held at the Hotel Radisson, Minneapolis, Minn., Sept. 26–28. A program of 23 technical sessions at which 49 papers will be presented has been arranged. In addition to a series of interesting plant trips in one of the largest industrial centers of the Midwest, the meeting will feature the Calvin W. Rice Lecture, by Frederick Oederlin, managing director, charge of engineering, Sulzer Brothers, Inc., Winterthur, Switzerland, and the Roy V. Wright Lecture by John W. Barriger, 3rd, president, Chicago, Indianapolis and Louisville Railway, Chicago, Ill.

Members who have not yet looked over the program are urged to refer to pages 680–682 of the August issue.

### Industrial Instruments and Regulators

The Industrial Instruments and Regulators Division is holding its 1951 annual conference as part of the program and exhibit sponsored by the Instrument Society of America, to be held at Houston, Texas, Sept. 10–14, 1951. Three technical sessions have been scheduled on such topics as aviation instruments, geophysical instruments, and cybernetics. Norbert Weiner, Instituto Nacional de Cardiologia of Mexico City, professor of mathematics, Massachusetts Institute of Technology, will be the feature discusser at the session on cybernetics.

For the list of papers to be presented, see page 683 of the August issue.

### Petroleum Conference

The Sixth Annual ASME Petroleum Mechanical Engineering Conference will be held at the Mayo Hotel, Tulsa, Okla., Sept. 24–26, 1951.

Forty papers have been arranged for discussion by the program committees of the Division as part of the 1951 program. For more details about this meeting and its program, see the following pages.

# Petroleum Division Announces Program for Sixth Annual Conference

## *Headquarters: Mayo Hotel, Tulsa, Okla., Sept. 24–26*

THE Sixth Annual Petroleum Mechanical Engineering Conference sponsored by the Petroleum Division of The American Society of Mechanical Engineers will be held at the Mayo Hotel, Tulsa, Okla., Sept. 24–26, 1951.

A technical program of direct appeal to the mechanical engineer in the petroleum industry with sessions conducted in an air-conditioned headquarters hotel plus the opportunity for oilmen to renew acquaintances in the "city that oil built" will be the attractions this year of the conference which has grown annually in support from its inception some six years ago.

### Tulsa, Center of Oil Industry

Tulsa, Oklahoma's second largest city and long known as the oil capitol of the world, is one of the Southwest's most beautiful and progressive metropolitan centers. The city includes more than 700 oil producing, refining, transporting, marketing, or special-service companies in the petroleum-industry field and is the control center for much of the oil exploration and development in the Southwest and Midwest areas. Tulsa is the world's purchasing market for the industry, the combined purchases of equipment exceeding a half-billion dollars annually. Because of its geographical position, the city of Tulsa is a key junction on national airline routes and has a municipal airport which ranks as the third largest commercial airport in the country in miles of runway. The city is also served by four railway systems.

Sixteen technical sessions are scheduled for the three-day conference. A total of forty papers will be presented at these sessions which will concern mechanical, operating, and design problems encountered in various aspects of oil production, oil transportation, oil refining, and material and equipment selection for the industry. Authors of these papers are authorities in their field and are associated with oil companies, petroleum-research laboratories, research institutes, material and equipment manufacturers, universities, and petroleum-industry service organizations.

### Special Tours Planned

Two inspection trips are also planned for the conference. The first, on Monday afternoon, will be to Bartlesville, Okla., to inspect the facilities of the Phillips Petroleum Company's new research laboratory. Following this tour a visit will be made to Woolaroc Ranch, 14 miles southwest of Bartlesville where the Woolaroc Museum is located. This museum tells the story of our country with particular emphasis on the Southwest. The story is told in sequence from the earliest known man in the New World, right up to the present day. Later, a barbecued buffalo supper will be held on the ranch for those making the inspection trip. The second inspection trip will be held late Wednesday afternoon and

will be a visit to the Mid-Continent Petroleum Corporation's Tulsa refinery, one of the world's largest and most modern independent oil refineries.

On Monday noon, the mayor of Tulsa will welcome the registrants at the conference at a luncheon which Pres. J. Calvin Brown will address. Then on Tuesday night, the Division's annual banquet will take place and be addressed by H. H. Anderson, vice-president and general manager of Shell Pipe Line Corporation, Houston, Texas.

Special events are planned for the ladies attending the conference on Wednesday. They will tour Tulsa, visit the Philbrook Art Center, lunch at the Tulsa Country Club, and visit the Thomas Gilcrease Museum.

Members attending the Conference will be required to pay a fee of $2 and nonmembers $3 for which each will receive a package of all available preprints of papers to be presented. Tickets for the luncheon, banquet, and inspection trips may be secured at a 10 per cent discount if purchased prior to Monday, September 24. Order tickets from C. O. Glasgow, ASME Tulsa Registration Chairman, National Tank Company, Box 1710, Tulsa 1, Okla.

## The Tentative Program

### MONDAY, SEPTEMBER 24

#### Pumping Equipment

**9:00 a.m.**

**Mathematical Analysis of Sucker-Rod Pumping Problem,** *E. N. Kemler*, chief, machine design and instrumentation division, Institute of Technology, University of Minnesota, Minneapolis, Minn.

**Long-Stroke Surface Hydraulic Pumping Units,** *L. D. Alward*, sales and service manager, The Pelton Water Wheel Company, Dallas, Tex.

**Air-Balanced Pumping,** *William G. Corey*, chief engineer, Lacy Oil Tool Company, Los Angeles, Calif.

#### Liquid Measurement

**9:00 a.m.**

**Differential Head Meters Useful to the Petroleum Industry,** *H. S. Bean*, Bureau of Standards, United States Department of Commerce, Washington, D. C.

**Notes on Positive-Displacement Meters for Liquid Hydrocarbons,** *E. W. Jacobson*, chief design engineer, Gulf Research and Development Company, Pittsburgh, Pa.

#### Pilot Plants

**9:00 a.m.**

**Pilot Plant Design in Scale Process Research,** *W. A. Horne, T. P. Joyce, B. M. Wedner*, Gulf Research and Development Company, Pittsburgh, Pa.

**Short Cuts in Pilot Plant Engineering,** *J. S. Rearick*, development engineer, The M. W. Kellogg Company, New York, N. Y.

**A Small Scale Plant for Studying Catalytic Reactions at High Pressures and Temperatures,** *C. M. Stiepcevich*, assistant professor chemical and metallurgical engineering, and *G. G. Brown*, dean, College of Engineering, University of Michigan, Ann Arbor, Mich.

#### Welcoming Luncheon

**12:00 Noon**

Presiding: *Robert G. Crits*, Bethlehem Supply Company, Tulsa, Okla.

Speaker: *J. Calvin Brown*, president ASME

### TUESDAY, SEPTEMBER 25

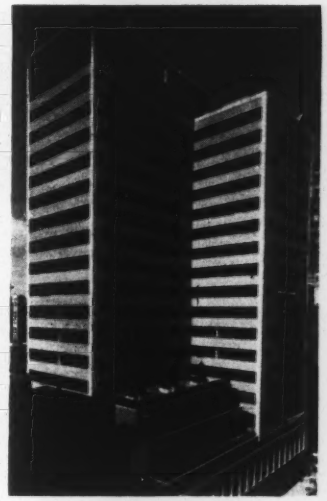
#### Drilling

**9:00 a.m.**

**Latest Developments in Percussion Drilling,** *R. Bassinger*, president, Bassinger Tool Company, San Antonio, Texas.

**Effect of Rock Properties on Drilling,** *W. B. Mather*, chairman of mineral technology, Southwest Research Institute, San Antonio, Texas.

**Slush Pump History and Possible Developments,** *R. E. Edwards*, Gardner Denver Company, Quincy, Ill.



ONE OF THE MODERN OFFICE BUILDINGS IN TULSA. IT IS THE 18-STORY FIRST NATIONAL BANK BUILDING WHICH WAS COMPLETED IN 1950

#### Welding

**9:00 a.m.**

**Welding Practices and Experiences With High-Yield-Point Pipe**

**Discussers:** *A. B. Wilder*, chief metallurgist, National Tube Company, Pittsburgh, Pa.; *John Montfort*, Mid-Valley Pipeline Company, Longview, Texas; *Bernard J. Brugge*, district manager, Lincoln Electric Company, St. Louis, Mo.; *F. W. Zilm*, Service Pipe Line Company, Tulsa, Okla.; *Karl L. Fetters*, ass't to vice-president—operations, Youngstown Sheet and Tube Company, Youngstown, Ohio; and *A. G. Barkow*, Natural Gas Pipe Line Company of America, Chicago, Ill.

#### Corrosion

**9:00 a.m.**

**Less Familiar Metals of Commercial Importance,** *R. A. Lubker*, assistant chairman, metals research, Armour Research Foundation, Chicago, Ill.

**Corrosion Resistance of Alloys in Amine Gas-Treating Systems,** *F. C. Riesenfeld*, senior research chemist, and The Fluor Corporation, Ltd.; *C. L. Blohm*, assistant manager research, Los Angeles, Calif.

**Analysis of Some Corrosion Problems in Petroleum Refineries,** *J. F. Mason, Jr.*, corrosion engineer, development and research department, International Nickel Company, Inc., New York, N. Y.

#### Offshore Drilling

**2:00 p.m.**

**Offshore Structures—Some Considerations in Their Design, Fabrication and Construction,** *M. B. Willey*, chief engineer, J. Ray McDermott and Company, Inc., Harvey, La.

**History of Magnetic Exploration,** *W. Ruska*, president, Ruska Instrument Corporation, Houston, Texas.

#### Pipe-Line Engines

**2:00 p.m.**

**High-Compression Spark-Ignition Gas Engines,** *George Steven*, executive engineer, Worthington Pump and Machinery Company, Buffalo, N. Y.

**Nordberg Supairthermal Diesel, Duafuel and Gas Engines Operating on the Miller Supercharging System,** *Ralph Miller*, chief engineer, four-cycle-Diesel division, Nordberg Manufacturing Company, Milwaukee, Wis.

#### Instrumentation

**2:00 p.m.**

**Automatic Control of Flow in Refineries,** *V. V. Tiry*, sales manager, The Foxboro Company, Foxboro, Mass.

**Modern Instrumentation Aids Economy in the Carbon-Black Industry,** *J. M. Ribble*, chief measurement and control engineer, gasoline department, Phillips Petroleum Company, Bartlesville, Okla.

**Performance of High-Pressure Instruments in the Bureau of Mines Synthetic Fuels Demonstration Plant,** *C. E. Balcersak* and *J. A. Skillern*, Bureau of Mines, Louisiana, Mo.

#### Banquet

**6:30 p.m.**

Presiding: *Francis Daasch*, Gulf Oil Corporation, Gypsy Division, Tulsa, Okla.

Speaker: *A. H. Anderson*, vice-president and general manager, Shell Pipe Line Corporation, Houston, Texas.

### WEDNESDAY, SEPTEMBER 26

#### Equipment

**9:00 a.m.**

**Gas Dehydration,** *L. L. Laurence*, chief engineer, Black, Sinalls and Bryson, Inc., Oklahoma City, Okla.

**Low-Temperature Separation for High-Pressure Gas Distillate Wells,** *C. O. Glasgow*, chief engineer, National Tank Company, Tulsa, Okla.

#### Operations

**9:00 a.m.**

**Conversion of Existing Diesel Engines to Dual Fuel,** *John L. Berggren*, president, Diesel Modification, Inc., Tulsa, Okla.

**Flow-Testing High-Capacity Pressure-Relief Valves,** *D. D. Buttolph* and *N. E. Ziege*, Phillips Petroleum Company, Bartlesville, Okla.

#### Design

**9:00 a.m.**

**Fatigue Tests of Piping Components,** *A. R. C. Markl*, chief research engineer, Tube Turns Inc., Louisville, Ky.

**Interaction of Pressure and Bending at Pipe Flanges,** *R. B. Blick*, Lee Factors Inc., Freeport, Texas.

**The Stresses in a Pressure Vessel With a Conical Head,** *G. W. Watts*, director of engineering, engineering research department, and *H. A. Lang*, project engineer, Standard Oil Company of Indiana, Chicago, Ill.

#### Materials

**9:00 a.m.**

**Metallurgical Factors Controlling Pipe Fittings Performance in the Petroleum Industry,** *E. O. Dixon*, vice-president, research and metallurgy, and *R. E. O'Brien*, Ladish Company, Cudahy, Wis.

**A New High-Yield-Strength Alloy Steel For Welded Structures,** *L. C. Bibber, J. M. Hodge, R. C. Altman, W. D. Doty*, research and development, United States Steel Corporation, Pittsburgh, Pa.

**Development of Metal-Arc Electrodes for Special Welding Applications,** *J. J. Chyle*, director—welding research laboratory, and *R. J. Keller*, assistant director, A. O. Smith Corporation, Milwaukee, Wis.

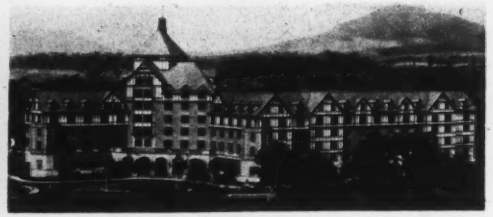
#### Pumping

**2:00 p.m.**

**Graphite-Impregnated Rubber Packing For Reciprocating Pumps and Oil-Well Stuffing Boxes,** *E. T. Skinner*, general manager, Skinner Brothers Rubber Company, Dallas, Texas.

**Some Kinematic Aspects of Pumping-Unit Mechanisms,** *E. N. Kemler*, professor of mechanical engineering, and *R. J. Howe*, teaching assistant, University of Minnesota, Minneapolis, Minn.

AERIAL VIEW OF DOWNTOWN TULSA, OKLA., WHERE THE SIXTH ASME PETROLEUM MECHANICAL ENGINEERING CONFERENCE WILL BE HELD SEPT. 24–26, 1951



ROANOKE HOTEL, ROANOKE, VA., HEADQUARTERS FOR THE 14TH JOINT AIME-ASME FUELS CONFERENCE TO BE HELD OCT. 11–12, 1951

**Problems Associated With Mechanical Seal-Retaining Assemblies on Centrifugal Pumps,** *L. T. Ellis, Jr.*, process engineering department, and *C. L. Fussel*, equipment inspection department, Esso Standard Oil Company, Baton Rouge, La.

### Pipe Line Control

**2:00 p.m.**

**Application of Pipe Line Control Equipment to Field Operations,** *H. T. Chilton, Jr.*, Service Pipe Line Company, Lubbock, Texas.

**Pipe Line Alarm and Control Circuits, Physical and Electronic,** *R. M. Slough*, superintendent of communications, The Ohio Oil Company, Findlay, Ohio.

### Equipment Selection

**2:00 p.m.**

**Vinyl Resin Coatings in Petroleum Refineries,** *C. G. Munger*, technical director, Amercoat Corporation, Los Angeles, Calif.

**Water-Cooling Towers and Air-Cooled Heat Exchangers in the Petroleum Industry—Their Selection, Operation and Maintenance,** *H. C. Degler*, technical director, The Marley Company, Inc., Kansas City, Mo.

**Techniques of Cost Estimating for Refineries,** *R. P. Wilson*, process engineering department, Mid-Continent Petroleum Corporation, Tulsa, Okla.

## Wool Processing Methods Topic for Textile Symposium

THE Textile Division of The American Society of Mechanical Engineers will hold a one-day meeting at the Copley-Plaza Hotel, Boston, Mass., on Sept. 21, 1951.

The meeting will be a symposium on conflicting new methods of wool processing. Robert Wilke, director of research of Pacific Mills, Lawrence, Mass., will begin the discussion with a paper on the Pacific Converter. The Ambler Superdraft System of wool processing will be described by Frank P. Pendleton, McGlynn-Hayes Industries, Inc., Belleville, N. J.

The afternoon program will be devoted to papers on current systems of wool preparation by proponents of each.

The Division serves the mechanical engineer in the textile industry by promoting meetings and discussions on mechanical problems and mechanization of the industry. One of its recent programs, "ASME Analyses Mill Modernization" is receiving much attention from engineers and the textile-industry press.

R. O. Palmer, secretary, Carlyle-Johnson Machine Company, Shrewsbury, Mass., is chairman of the ASME Textile Division.

## 14th AIME-ASME Joint Fuels Conference to Be Held Oct. 11–12, 1951

THREE symposiums, which will take up in turn, desliming of fine solids, engineering service in the coal industry, and fuel and equipment consulting service for small steam generating plants, will be a feature of the 14th Joint Fuels Conference of the Coal Division of the American Institute of Mining and Metallurgical Engineers and the Fuels Division of The American Society of Mechanical Engineers. The conference will be held at the Roanoke Hotel, Roanoke, Va., Oct. 11-12, 1951.

In addition to the panel discussions, there will be a fourth technical session during which four papers will be presented on changing characteristics of storage coal, air pollution from gob piles, determination of free swelling index of coal employing electric furnaces and heaters, and relationship between filter-cake size-consist and moisture.

R. H. Smith, president, Norfolk and Western Railway Company, will be the speaker at the first general luncheon at which C. E. Miller, chairman of the ASME Fuels Division, will preside.

A feature of the banquet, to be held on Thursday, October 11, will be the presentation of the 1951 Percy Nicholls Award to A. R. Mumford, Fellow ASME, development engineer, Combustion Engineering-Superheater, Inc., New York, N. Y. This award was established in 1942 and is presented annually for notable scientific and industrial achievement in the field of solid fuels. Julian E. Tobey, president, Appalachian Coals Inc., Cincinnati, Ohio was last year's recipient.

Mr. Mumford has served successively as research and design engineer for the New York Steam Corporation, associate director of research for the Consolidated Edison Company of New York, and currently as development engineer of the Combustion Engineering Superheater Inc. He has contributed to advancement of combustion of anthracite on chain-grate stokers and to the solution of problems associated with furnace performance factors and other electric-utility and steam-generation problems.

Walter S. Newman, president, Virginia Polytechnic Institute, Blacksburg, Va., will be the main speaker at the banquet at which C. A. Garner, chairman, AIME Coal Division, will preside.

For the entertainment of the women attending the conference, an interesting program has been arranged which will include a bridge-canasta party and tea on the first day of the conference and a visit to the Natural Bridge of Virginia and a luncheon at the Natural Bridge Hotel on the second day. Visits are also planned to the campuses of the Virginia Military Institute and Washington and Lee University.

In planning the conference the committees in charge were fortunate in selecting the Roanoke Hotel, which is an English style inn with comfortable rooms, fine appointments, spacious convention facilities, and an excellent cuisine. The facilities of the Roanoke Country Club and the beautiful Virginia countryside are inducements to combine the conference with a few days of vacation.

The technical program follows:

### THURSDAY, OCTOBER 11

**9:00 a.m.**

**Registration**

**9:30 a.m.**

**Thickening and Desliming Symposium**

**Operational Data for Cyclone Thickener Operations,** by *J. P. Blair*, Heyl and Patterson

**Low-Cost Industrial Desliming of Fine Solids,** by *D. A. Dahlstrom*, Northwestern University

**Slurry Thickening With the Stream Cleaner,** by *K. Prins*, K. Prins and Associates

**Operational Data for the Locust Summit Thickener,** by *H. R. Hagen*, Philadelphia and Reading Coal and Iron Company

Other speakers: *John Griffin*, McNally-Pittsburgh Company; *E. B. Nelson*, Tennessee Coal Iron and Railroad Company; and *Victor Phillips*, Eastern Gas and Fuel Associates

**12:15 p.m.**

**Luncheon**

Presiding: *C. E. Miller*, chairman, Fuels Division, ASME

Speaker: *R. H. Smith*, president, Norfolk and Western Railway Company

**2:00 p.m.**

**Engineering Service in the Coal Industry**

Speakers: *U. B. Yeager*, Island Creek Coal Sales Company; *George P. Cooper*, Empire-Hanna Corporation; *Max A. Tuttle*, Rhos Coal Mining Company; and *E. J. Kerr*, Baltimore and Ohio Railroad

7:15 p.m.

**Banquet**

Presiding: *C. A. Garner*, chairman, Coal Division AIME

Speaker: *Walter S. Newman*, president Virginia Polytechnic Institute

**FRIDAY, OCTOBER 12**

9:00 a.m.

**Technical Session**

**Determination of Free Swelling Index of Coal Employing Electric Furnaces and Heaters**, by *R. Swarisman* and *G. C. Behnke*, Canadian Bureau of Mines

**Air Pollution From Gob Piles**, by *Henry F. Hebly*, Pittsburgh-Consolidation Coal Company

**Changing Characteristics of Storage Coal**, by *T. F. Downing, Jr.*, Philadelphia Electric Company

**Filter-Cake Size-Consist and Moisture Relationships**, by *O. R. Lyons*, Republic Steel Corporation

2:00 p.m.

**Fuel and Equipment Consulting Service for Small Steam-Generating Plants**

**The Viewpoint of the Small-Plant Owner**, by *A. R. Miller*, General Foods Corporation

**The Viewpoint of the Coal Producer**, by *Earl C. Payne*, Pittsburgh Consolidation Coal Company

**The Viewpoint of the Consulting Engineer**, by *H. C. Carroll*, Commercial Engineering and Testing Company

**The Viewpoint of the Equipment Manufacturer**, by *B. C. Webb*, Iron Fireman Corporation

**The Viewpoint of the Construction Contractor**, by *W. S. Major*, Dravo Corporation

# ASME Standards Workshop

## Plumbing Code

WITH the distribution of the report of the Co-Ordinating Committee for a National Plumbing Code, the second major step was taken in the formulation of a single code incorporating the best features of five plumbing codes currently in use on the national level. It is hoped that the proposed draft will be acceptable to users, manufacturers, and municipalities in all sections of the country.

The first step taken toward a national plumbing code was in 1949 when the plumbing code of the Department of Commerce was harmonized with the American Standard, ASA A40.7 with the aid of 30 co-operating organizations under the sponsorship of The American Society of Mechanical Engineers and the American Public Health Association.

The report of the Co-Ordinating Committee has been issued in the form of a proposed code which adjusts differences of major codes now in use in the United States. These are: American Standard Plumbing Code, Uniform Plumbing Code of the Department of Commerce, Western Plumbing Officials Code, Code of the Building Officials Conference of America, and The American Society of Sanitary Engineers Code. It reports the consensus of the members of the Co-Ordinating Committee and its advisory committee and is based on experience and conclusions reached from research in the field of plumbing conducted at university and government laboratories. This research, according to the committee, has made possible a better understanding of plumbing phenomena observed in service and has enabled the committee to propose improved code requirements.

The document represents two years of intensive work by representatives of organizations responsible for developing the various current codes. In distributing its report in the form of a proposed unified national plumbing code, the committee is urging users and manufacturers and others concerned with sanitation to read the recommended provisions carefully and to submit comments on the proposals. Copies may be obtained by writing to ASME Standards Department, 29 West 39th Street, New York 18, N. Y.

## Shafting and Stock Keys

PROGRESS was reported on the revision of the two standards, Shafting and Stock Keys, B17.1-1943, and Woodruff Keys, Keyslots, and Cutters, B17.F-1930, under the jurisdiction of the Sectional Committee on Standardization of Shafting and Stock Keys, B17. A meeting was held in Chicago, Ill., on June 6, 1951, attended by W. H. C. Berg, Harold F. Watson, G. R. Caskey, an alternate for C. L. Kent, and H. C. Hesse, chairman.

Among the items discussed was the revision of the questionnaire on changes which should be included in the revised standards. Mr. Watson accepted the responsibility for undertaking this revision. Following a discussion of a request from the Association of Roller and Silent Chain Manufacturers for standardization of keyway sizes for shafting below $^1/_2$ in. and greater than $5^1/_2$ in. in diameter, it was agreed that questions be included in the revised questionnaire polling manufacturers on their present practice in selecting keys for these shafting sizes.

The American Standard Code for Transmission Shafting, B17.c-1927, also under the committee's jurisdiction, needed revision, according to some members of the committee. Mr. Hesse stated that additional material on shaft deflection and vibrational frequencies, both of which are important in the design of transmission shafting with long overhangs, such as used in agitating equipment, would be a useful addition to the revised standard.

The possibilities of rounded corners on keys also came under discussion. It was felt that this subject should be introduced into the questionnaire if there was any possibility that the rounded-corner keyway and keyseat were to be used extensively in the future.

The committee agreed to meet during the 1951 ASME Annual Meeting at Atlantic City.

## Surface Qualities

APPROVAL by the Sectional Committee B46 on the classification and designation of surface quality of a proposed American Standard, Physical Specimens of Surface Roughness and Lay, clears the way for formal designation of the draft as an American Standard. The proposed standard prescribes specifications for two types of specimens for surface roughness and lay. The first type covers precision specimens intended for calibrating instruments for measuring surface roughness. The second type is intended to illustrate commonly used machined surfaces.

The Sectional Committee is currently organizing a subcommittee to develop proposals for standardizing instruments for measuring surface finish. The committee is participating in the trend toward unification of American, British, and Canadian standards by meeting informally with representatives of the British Standards Institution in New York, N. Y., to discuss the possibilities of unification.

## ASME Calendar of Coming Events

**Sept. 10–14**
ASME Industrial Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Houston, Texas
*(Final date for submitting papers was May 1, 1951)*

**Sept. 24–26**
ASME Petroleum Mechanical Engineering Conference, Hotel Mayo, Tulsa, Okla.
*(Final date for submitting papers was May 1, 1951)*

**Sept. 26–28**
ASME Fall Meeting, Hotel Radisson, Minneapolis, Minn.
*(Final date for submitting papers was May 1, 1951)*

**Oct. 11–12**
ASME Fuels and AIME Coal Division Joint Conference, Hotel Roanoke, Roanoke, Va.
*(Final date for submitting papers was June 1, 1951)*

**Nov. 25–30**
ASME Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.
*(Final date for submitting papers was July 1, 1951)*

**March 24–26, 1952**
ASME Spring Meeting, University of Washington, Seattle, Wash.
*(Final date for submitting papers—Nov. 1, 1951)*

**June 15–19, 1952**
ASME Semi-Annual Meeting, Sheraton Gibson Hotel, Cincinnati, Ohio
*(Final date for submitting papers—Feb. 1, 1952)*

**June 19–21, 1952**
ASME Applied Mechanics Division Conference, The Pennsylvania State College, State College, Pa.
*(Final date for submitting papers—Feb. 1, 1952)*

**June 23–27, 1952**
ASME Oil and Gas Power Division Conference, Hotel Statler, Buffalo, N. Y.
*(Final date for submitting papers—Feb. 1, 1952)*

**Sept. 8–11, 1952**
ASME Fall Meeting, Sheraton Hotel, Chicago, Ill.
*(Final date for submitting papers—May 1, 1952)*

**Sept. 8–12, 1952**
ASME Industrial Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Cleveland, Ohio
*(Final date for submitting papers—May 1, 1952)*

**Sept. 22–24, 1952**
ASME Petroleum Mechanical Engineering Conference, Hotel President, Kansas City, Mo.
*(Final date for submitting papers—May 1, 1952)*

**Nov. 30–Dec. 5, 1952**
ASME Annual Meeting, Statler Hotel, New York, N. Y.
*(Final date for submitting papers—July 1, 1952)*
*(For Meetings of Other Societies see page 766)*

## Calvin W. Rice Scholarship Awarded to English Student

THE Calvin W. Rice Memorial Scholarship Fund of the Woman's Auxiliary to The American Society of Mechanical Engineers has been awarded to Lewis Eric Russell, of England, a graduate of the University of Sheffield in 1948.

Mr. Russell has specialized in furnace design and has had three years' experience in the English glass and petroleum industries.

Mr. Russell, who has requested tuition and partial maintenance, is eligible for transportation under the Fullbright Travel Grant. He will enter Massachusetts Institute of Technology to continue study of furnace design, working toward his doctor's degree.

Upon completion of his studies, he expects to return to England and do consulting work in British industry.

## ASME Symposium on High Pressure Planned for 1952

THE Industrial Instruments and Regulators Division of The American Society of Mechanical Engineers announced recently that plans are rapidly developing for its High-Pressure Symposium to be held during its annual conference at Cleveland, Ohio, Sept. 8–12, 1952.

Although the instrumental side of high-pressure work will be stressed, a well-rounded program will be presented, covering all fields of interest relating to current operations in the pressure range from 10,000 to 150,000 psi.

Papers are being solicited on the design of instruments for measuring pressures and for measuring the physical properties of materials in this range. Also to be included are papers on the design of apparatus and plumbing used to develop, transmit, and contain these pressures.

The tentative program includes papers in the following groups: (1) Survey and historical; (2) measurements; (3) properties of materials; (4) pressure vessels; and (5) pumps and pumping.

It is expected that the symposium papers will be published in a single volume, which will represent the current state of knowledge on high-pressure technology.

W. H. Howe, chief engineer, The Foxboro Company, Foxboro, Mass., will be in general charge of the arrangements. Mr. Howe is a graduate of Worcester Polytechnic Institute, Woscester, Mass. Since 1936 he has been associated with The Foxboro Company as field engineer, director of research, and at present as chief engineer.

Interested authors are requested to submit an abstract of their proposed papers to Mr. Howe at as early a date as possible. Deadline for the completed manuscripts is May 1, 1952.

# The ASME Budget for 1951–1952

ANTICIPATING the natural interest of the members about the effect of the increased dues on services rendered by the Society, the Council authorized a more elaborate presentation of the budget for 1951–1952 than is customarily made in MECHANICAL ENGINEERING at this time.

The new rates of dues go into effect October 1, 1951, the start of the next fiscal year. Estimating the income from dues on the new basis presented a problem about which there is no previous experience and the decision was made to remain on the conservative side in estimating dues income and all other income items. Two factors in dues income should be pointed out. One was the fact that about 1000 older veterans who came in as Juniors will pay less dues than formerly. The other was the number of votes against the increase in dues which indicated possible larger withdrawals than usual.

The Council followed its usual procedure in

TABLE 1 COMBINED ANALYSIS OF EXPENDITURE BUDGET 1951–1952

| | Under Committee Supervision | | | | | |
|---|---|---|---|---|---|---|
| | Direct Expenditure | Joint Bodies | Members Travel | Printing and Distribution | Office Expense | Total |
| PUBLICATIONS, STANDARDS, CODES, AND RESEARCH | | | | | | |
| MECHANICAL ENGINEERING text pages (excluding student copies) | | | | $ 78,000 | $ 32,500 | $ 110,500 |
| MECHANICAL ENGINEERING advertising pages (excluding student pages) | | | | 126,100 | 85,449 | 211,549 |
| Transactions (including *Journal of Applied Mechanics*) | $ 1,100 | | | 13,800 | 18,560 | 33,460 |
| Membership List | | | | 8,000 | | 8,000 |
| ASME Catalog | | | | 57,500 | 43,365 | 100,865 |
| Publications sales (except standards codes, and research reports) | | | | 55,500 | 19,564 | 75,064 |
| Standards and codes | | $ 1,000 | | 63,500 | 82,693 | 147,193 |
| Research | | | | 1,500 | 4,040 | 5,540 |
| GENERAL SOCIETY ACTIVITIES | | | | | | |
| Society Meetings (including publicity) | 33,000 | | | | 17,325 | 50,325 |
| Sections (including regional admin. Com. of Regional Delegates Conference) | 60,000 | | $ 14,500 | | 19,096 | 93,596 |
| Professional Divisions | 7,700 | | | | 14,525 | 22,225 |
| Student Branches (including copies of MECHANICAL ENGINEERING text & adv. pages) | 5,000 | | 3,500 | 20,000 | 14,234 | 42,734 |
| Admissions | | | | | 19,976 | 19,976 |
| Development | | | | | 4,530 | 4,530 |
| Awards | 1,100 | | | | 696 | 1,796 |
| Engineers Civic Responsibility | | | 500 | | | 500 |
| GENERAL SOCIETY ADMINISTRATION | | | | | | |
| Council | 2,300 | | 6,000 | | | 8,300 |
| Professional services (auditors, counsel, etc.) | 6,500 | | | | | 6,500 |
| Nominating Committee | | | 2,000 | | | 2,000 |
| Retirement Fund | 35,800 | | | | | 35,800 |
| "Know Your Society" (organization charts) | | | | 500 | | 500 |
| JOINT ACTIVITIES | | | | | | |
| Engineering Societies Library | | 15,350 | | | | 15,350 |
| Engineers' Council for Professional Development | | 1,900 | | | | 1,900 |
| Engineers Joint Council | | 1,500 | | | | 1,500 |
| Engineering Societies Personnel Service, Inc. (reserve) | | 500 | | | | 500 |
| Registration (National Council of State Boards of Engineering Examiners) | | 500 | | | | 500 |
| UET pension fund | | 3,300 | | | | 3,300 |
| National Management Council | | 500 | | | | 500 |
| INDIRECT EXPENSE | | | | | | |
| Secretary's office | | | | | 50,566 | 50,566 |
| Accounting department | | | | | 44,288 | 44,288 |
| General service (stores, mailing, filing, etc.) | | | | | 95,430 | 95,430 |
| General Office (rent, insurance, etc.) | | | | | 46,690 | 46,690 |
| | $152,500 | $24,550 | $26,500 | $424,400 | $613,527 | $1,241,477 |

establishing the budget by adopting it at the Semi-Annual Meeting and providing for a revision in the following spring when income figures for the year can be more accurately determined. In the spring revision, consideration can be given to the possibility of increasing services on the basis of increased dues income. The budget as adopted provides for the maintenance of present services. The budget also provides for a six per cent increase in staff salaries, necessary under present circumstances.

The Council has also set up a planning committee to review the present organization, objectives, and services and to recommend any changes that will provide better service to members.

The attached tables show the expenditure budget for 1951–1952. There is also a comparison of the cost of service breakdown of the budget for 1950–1951 as adopted in June, 1950, and a similar analysis for the budget for 1951–1952 as adopted in June, 1951, with explanatory notes.

C.E.D.

TABLE 2 COSTS OF SERVICE—ASME ACTIVITIES COMPARISON OF BUDGETS FOR 1950–1951 AND FOR 1951–1952[a]

| | 1950–1951 | | 1951–1952 | |
|---|---|---|---|---|
| ACTIVITIES PRODUCING NET INCOME | | | | |
| MECHANICAL ENGINEERING and Mechanical Catalog Income | $410,000 | | $475,000 | |
| Less production costs, wages, and indirect | 303,442 | $106,558 | 379,052 | $ 95,948[b] |
| Engineering Index | | 3,000 | | 3,000 |
| Miscellaneous sales | | 7,500 | | 6,000[c] |
| Interest and discount | | 18,000 | | 19,000[d] |
| Membership dues | | 450,000 | | 530,000[e] |
| ACTIVITIES CARRIED ON AT NET EXPENSE | | 585,058 | | 653,948 |
| MECHANICAL ENGINEERING text (production, wages, and indirect) | | $115,145 | | $132,995[f] |
| Transactions (production, wages, and indirect) | | 43,157 | | 41,828 |
| Membership List (production, wages, and indirect) | | 9,494 | | 9,544 |
| Standards and Codes income | $115,000 | | $117,000 | |
| Stock cost, wages, and indirect | 163,972 | 48,972 | 178,346 | 61,346[g] |
| Research income | 11,000 | | 3,000 | |
| Stock cost, wages, and indirect | 13,511 | 2,511 | 6,833 | 3,833[h] |
| Student dues | 48,000 | | 18,000 | |
| Expense (production appropriations, wages, and indirect) | 91,006 | 43,006 | 51,392 | 33,392[i] |
| Meetings income | 2,000 | | 2,000 | |
| Expense (costs, wages, and indirect) | 52,024 | 50,024 | 60,384 | 58,384[j] |
| Sections (appropriations, travel, wages, and indirect) | | 105,280 | | 112,226[k] |
| Divisions (appropriations, travel, wages, and indirect) | | 27,206 | | 26,887 |
| Admissions and development (wages and indirect) | | 31,404 | | 30,165 |
| Awards (costs, wages, and indirect) | | 1,894 | | 2,142 |
| Engineers Civic Responsibility | | 500 | | 500 |
| Joint Activities (appropriations and indirect) | | 41,030 | | 43,590[l] |
| General Administration (appropriations, wages, and indirect) | | 59,960 | | 73,523[m] |
| General Publications Sales Income | 74,000 | | 80,000 | |
| Expense (costs, wages, and indirect) | 77,997 | 3,997 | 92,070 | 12,070 |
| TOTAL | | 583,580 | | 642,425 |
| NET INCOME | | $ 1,478 | | $ 11,523 |

*(The total of all income items in the above tabulation is $1,253,000. The total of all expense items is $1,241,477 the same as is reported in Table 1.)*

[a] In considering this comparison of budgets, it is important to remember that the figures are prepared from fifteen to eighteen months before the close of the respective periods and in preparing the figures conservative estimates are used. However, as each set of figures is prepared under similar circumstances, comparison between the two years is in order.

[b] *Advertising Income:* Increased advertising rates and increased volume will produce increased income but possible increases in production costs reduce the net income. In view of the uncertainties over the next year, these figures are conservative.

[c] *Miscellaneous Sales:* Possible reduced number of new members will reduce income from badges and membership certificates.

[d] *Interest and Discount:* Diversification of investments, directed by the Council, will improve income.

[e] *Membership Dues:* Because of some uncertain factors in the dues income, from newly increased rates of dues, and to be conservative, full effect of the dues increase estimated at $90,000 was not used in making this estimate. The figure for 1951–1952 is $30,000 or 6 per cent more than the dues income would have been had the old rate of dues remained in effect.

[f] *Mechanical Engineering Text:* The 1951–1952 figure provides for possible increases in production costs and for sixty more pages than were provided in the 1950–1951 budget.

[g] *Standards and Codes:* Increased net expense due to increased cost of publications sold and an increase in allocation of indirect expense.

[h] *Research:* Reduced program of publications will reduce income and expense. A major research report is in process and if it is published in 1951–1952, the sales income will result in a reduced net expense.

[i] *Student Dues:* Drastic reduction in engineering enrollment in the schools will reduce both income and expense. The expenses always exceed the income.

[j] *Meetings:* Increase in appropriations for meetings, for publicity, and for travel of staff. The Annual Meeting in Atlantic City in 1951 will cost about four thousand dollars more than an Annual Meeting held in New York City.

[k] *Sections:* Increase due to past year's increase in size of Sections and provision for new Sections and Sub-Sections.

[l] *Joint Activities:* Increase due to normal increase in appropriations for Library and UET Pension and increase in staff time devoted to joint activities.

[m] *General Administration:* Increase due to (1) addition of Social Security for Society employees; (2) normal increase in retirement fund payments; (3) increase in professional services, legal and investment counsel; and (4) increase in amount of Council travel.

# Junior Forum

## Junior Members Talk About Manpower Shortage at Toronto Conference

THE impact of the engineering manpower shortage on career planning of recent graduates was the subject reviewed at a conference sponsored by the National Junior Committee of The American Society of Mechanical Engineers and held during the ASME Semi-Annual Meeting in Toronto, Ontario, Can.

The conference was the second of four planned for 1951 under the general theme, "A Current Plan for Young Engineers." In accordance with a procedure worked up by the National Junior Committee with the financial support of the Old Guard Committee headed by F. D. Herbert, ASME Sections in the Regions in which a national meeting is to be held appoint junior delegates to participate in the conferences. Expenses of junior delegates are partially defrayed by the Old Guard Committee. Junior delegates come prepared to discuss career-planning problems and to comment on some talk by an eminent engineer.

Informality and an earnest exchange of information and opinion between engineers of attainment and those who have recently entered upon an engineering career, are the characteristics which have consistently attracted good audiences.

### Carey H. Brown Addresses Juniors

At Toronto, more than 120 heard Carey H. Brown, chairman of Engineering Manpower Commission of Engineers Joint Council talk about "Meeting the Critical Shortage of Engineers."

Mr. Brown stressed the increasing importance of the engineering profession to the national economy and the defense effort. The current shortage of engineers will increase, Mr. Brown said, because of the falling off of enrollment in engineering colleges. He cited the results of a recent EJC survey which showed that 80,000 engineers were needed by American industry. The 1951 graduating class numbered only about 38,000 of whom about half were to enter military service, leaving the unfilled demand at 60,000. In 1952, Mr. Brown continued, the graduating class will be about 26,000, in 1953 about 17,000, and in 1954, only 12,000.

The decrease was due to several factors. The termination of the GI program; the low birth rate in the early 1930's; and a failure to anticipate increased demand and to encourage more boys to train for the profession.

The Engineering Manpower Commission, he said, was currently working to defer from military service more engineering students and recent graduates. In view of the continuing shortage, the Engineering Manpower Commission was developing a program to encourage more effective use of engineering talent now available in industry and the armed services. Since the defense effort was based on the premise that the United States cannot match potential enemies in numbers of men, but must excel them in quality and quantity of equipment, it was vital, Mr. Brown pointed out, that none of our technical manpower be wasted.

### Junior Delegates From Region V

During the discussion period, the following Junior delegates representing sections in Region V, carried on an extended discussion of points introduced by Mr. Brown: *Youngstown*, Don Block; *Ontario*, John D. Bourns; *Pittsburgh*, John T. Bunting; *West Virginia*, Frank J. Butler; *Columbus*, Owen E. Buxton, Jr.; *Detroit*, David J. Cronberger; *Dayton*, David M. Goldzwig; *Cincinnati*, Robert W. Howorth; *Canton-Alliance-Massillon*, George E. Kaufman; *Cleveland*, Donald L. Lynch; *Erie*, John E. Tormey, Jr.; *Toledo*, Ernest W. Weaver, Jr.; and *Akron*, A. F. Weber, Jr.

Mr. Kaufman of the Canton-Alliance-Massillon Section reported that his Section was working with high schools to promote freshmen enrollments in engineering schools. By cooperating with high-school advisers, local engineers have sought to reduce the mortality rate in the colleges by encouraging only those boys who have engineering aptitudes. Mr. Kaufman recommended this plan for other Sections as a useful service.

Others commented that in Russia the bachelor degree in engineering was virtually discontinued in favor of carrying various students to the master or doctorate level and training a much greater number of technicians in one or two-year courses. It was pointed out that in the United States, there was a tendency to use graduate engineers in technician capacities. This was true in industry as well as in the Armed Forces.

A Canadian engineer, after describing the military classification used in the Canadian Armed Forces, elicited the comment from one of the U. S. graduates that his country could profit by studying Canadian methods.

Another point made by the young men was that industry must present adequate incentives for men to enter and remain in the engineering field. These must include more adequate financial differences from certain of the semi-skilled trades, better recognition of professional standing, and utilization of each engineer at the highest degree of responsibility of which he is capable. Otherwise, the versatility and resourcefulness which are characteristic of engineers will seek more adequate compensation in other fields, and our engineering manpower will diminish.

Reported by J. R. DAVIDSON.

## Engineering Societies Personnel Service, Inc.

*These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.*

| New York | Chicago | Detroit | San Francisco |
|---|---|---|---|
| 8 West 40th Street | 84 East Randolph Street | 100 Farnsworth Avenue | 57 Post Street |

### Men Available[1]

**Executive Engineer,** mechanical, consulting, sales, Diesel or heavy machinery, management, etc. Designer, manufacturer, and patentee of Diesel-marine and industrial engines 4-hp to 1200-hp slow-speed and high-speed units. Diesel fuel injection, heavy machinery, also small intricate machine assemblies, etc. Over 30 years' experience Diesel-marine, machine shop, tools and jigs, industrial maintenance and construction, electrical power plants, development engineer, hydraulic circuits, etc. Prefers West or Midwest. Me842.

**Mechanical Engineer,** 25, veteran, married, family, one year varied design and production experience in close-tolerance work. Desires planning, production position with responsibilities. Prefers metropolitan New York area. Me-843.

**Mechanical Engineer,** 26, married, BSME, 1½ years' experience designing heating, air-conditioning, and plumbing systems, equipment layout, supervision of construction for large commercial and industrial buildings. Desires permanent position of responsibility leading to plant engineer. Principally West. Me-844-151-C.

[1] All men listed hold some form of ASME membership.

**Junior Engineering Assistant,** BS (sought) senior now, 24. Supervision of construction work, installation of substructure and superstructure of power-plant extension, erection of cooling tower, boiler alterations, handling field-work reports, correspondence, contracts and specifications. Engineering assistant. Midwest. Me-845-149-C.

**Project Engineer,** BSE, industrial-mechanical, 30, 2 years drafting, 1 year machine shop, 1½ years design, development, testing precision hydraulic mechanisms, four years AAF administrative and technical. Desires position as project engineer or assistant chief engineer small firm. Midwest. Me-846-150-C.

**Engineer or General Executive,** ME registered, forty years' versatile practical experience in all phases of development, engineering and production of intricate mechanical devices, large or small. Expert on production of precision military materiel. Specialist on plant organization. Chicago area. Me-847-152-C.

**Mechanical Engineer,** 33, with master's degree in vibrations and applied mathematics, desires responsible industrial position or associate professorship. Industrial experience with fluid meters. Ten years' teaching and laboratory experience. Me-848.

*(ASME News continued on page 776)*

# PRODUCE MORE WITH YARWAYS...

Is higher production your aim?

Then Yarway is your steam trap. Best steam trap performance requires condensate drainage *plus*—

1. **Air and gas removal.**
2. **Velocity scrubbing of condensate from heat transfer surfaces.**
3. **Keeping highest average temperature in the equipment.**

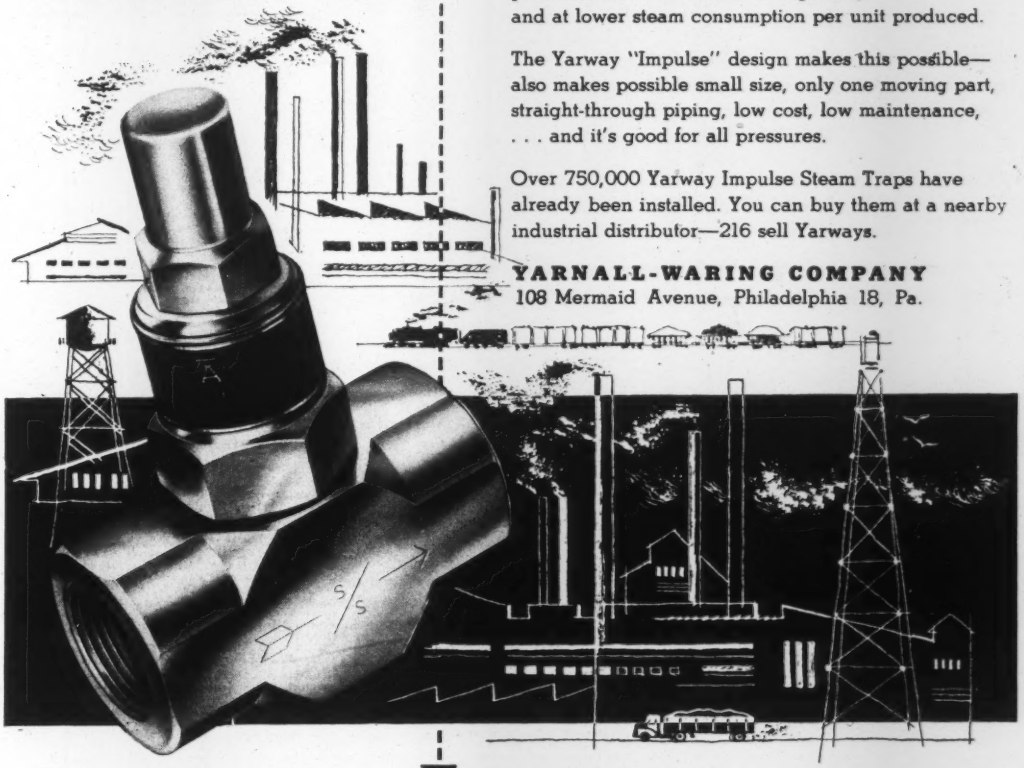
Yarway Impulse Steam Traps do all this, *sending the most premium B.T.U.'s at top temperature into your process or product.*

That's why equipment drained with Yarways gets "hotter, sooner" . . . why better quality and higher production rates are so often reported, and at lower steam consumption per unit produced.

The Yarway "Impulse" design makes this possible—also makes possible small size, only one moving part, straight-through piping, low cost, low maintenance, . . . and it's good for all pressures.

Over 750,000 Yarway Impulse Steam Traps have already been installed. You can buy them at a nearby industrial distributor—216 sell Yarways.

**YARNALL-WARING COMPANY**
108 Mermaid Avenue, Philadelphia 18, Pa.



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**Don't take our word for it. Test Yarway's production advantages in your own plant, without cost or obligation. Drop us a card. A trial trap will be delivered promptly.**

**YARWAY the steam trap designed with production in mind**

## Positions Available

**Manufacturing Engineer,** two to four years' experience working with special-purpose small precision machinery. Should have experience in methods, plant layout, and production planning. $5000–$6000. Midwest. Y-5724.

**Chief Engineer** for paper factory, over 30, mechanical graduate, at least five years' experience after election as an A.M.I.M.E., or after obtaining equivalent professional qualifications. Will check drawings of foundations and supervise the construction of the building of the factory and the erection of paper machinery and accessories, and then be in charge of the operation and maintenance of all machinery and equipment. Ceylon. Y-5730.

**Materials-Handling Engineer,** minimum of five years' experience in materials handling, particularly for industrial operations. Must know operating costs. $10,000–$12,000. New York, N. Y. Y-5752.

**Mechanical Engineers,** several years' experience on petroleum, oil, and lubricant work, including tank and distribution systems used in airport work. Some knowledge of small power plants, plumbing, heating, and refrigeration required. $11,180. Turkey. Y-5779(a).

**Junior Industrial Engineer,** 25–35, graduate in industrial or mechanical engineering, with graduate business-school training in accounting equally satisfactory, three to five years' general industrial-engineering experience including some standard cost work if possible. Will do consulting work primarily with New England clients on problems such as wage incentives, standard cost, variable budget, job evaluation, etc. $5000–$7000. Frequent traveling. Headquarters, Boston, Mass. Y-5802.

**Chief Mechanical Engineer** to take over a department. Must be throughly experienced in power plants, steam or Diesel, and must be a U. S. citizen. $9000. New York, N. Y. Y-5822.

**Staff Development Engineer** to assist head of division who reports to president; 35–45, mechanical-engineering degree, with design, testing, and industrial-research experience with leaning toward theoretical side of engineering. Company manufactures major household appliances, liquid-dispensing equipment, etc. Primary activity will be in research and development for improvement in present products and of new products. Salary open. Vicinity of Philadelphia, Pa. Y-5836.

**Industrial Engineer-Assistant Controller,** 37–39, college degree, experience in industrial engineering in a processing as opposed to a fabricating company, i.e., paper, textiles, chemicals, etc., plus some accounting experience. In the beginning emphasis will be on industrial engineering, as the industrial-engineering functions diminish the accounting work will increase and lead eventually to the title of assistant controller. $8000–$10,000. N. J. Y-5837.

**Engineers.** (*a*) Senior designer, mechanical, high-speed automatic machinery experience, to design special equipment. (*b*) Quality control manager to be responsible for inspection, analysis of production, preparation of statistical data etc., covering metal products and equipment. $7000–$8500. Conn. Y-5849.

**Mechanical-Job Engineer,** 28–35, at least five years' chemical-plant engineering or process-equipment-design experience, to set up specifications, prepare plans and proposals for crystallization equipment. Salary open. Western Pa. Y-5856.

**Mechanical Engineer,** degree, five to ten years' power-plant design and layout experience, to select, purchase, and lay out industrial power equipment for oil refinery. $4800–$6360. Northern N. J. Y-5857.

**Mechanical Engineer** for designers and manufacturers of process equipment of stainless, alloy steels, and carbon steel for the chemical, petroleum and allied industries, equipment such as autoclaves, reactors, mixing equipment, fractionating columns, heat exchangers, condensers, etc. Should have experience in this field and possibly chemical-plant operating experience. Northern N. J. Y-5861.

**Chief Mechanical Designer** for steam-power plant. Must have had considerable experience, especially in public utilities. Will head up a small mechanical-design department. Salary open. New York, N. Y. Y-5872.

**Mechanical-Engineering Assistant,** 24–30, four years college in mechanical engineering, and one to two years' experience in office doing drafting, computations, design building, appurtenance, general mechanical-engineering work. Will do general mechanical-engineering work over broad field applying to industrial and building work for a meat-packing company. $3900–$5200. Iowa. T-8041.

## Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after Sept. 25, 1951, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

### KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

### NEW APPLICATIONS

*For Member, Associate, or Junior*

ALEXANDER, GEORGE S., Peterboro, Ont., Can.
ALI, KHURSHEED, Milton, Mass.
ALT, THEODORE E., Jr., Staten Island, N. Y.
ARSCOTT, JOSEPH W., Penal, Trinidad, B. W. I.
BANKS, VERE J., Jr., Lebanon, Pa.
BATHURST, LYNN L., Jackson, Mich.
BELDECOS, NICHOLAS A., Chester, Pa.
BOLES, REUBEN S., Jr., Alhambra, Calif.
BRENTON, WALTER, Portland, Ore.
BUOT, ANTONIO, Portland, Ore
CARRUTHERS, W. K., Montreal, Que., Can.
CHRISTENSEN, CHESTER W., San Francisco, Calif.
CLEARY, JOHN F., Dayton, Ohio
CORLHO, PEDRO L. C., Rio de Janeiro, Brazil, S. A.
COMTOIS, WILFRED H., Wellsville, N. Y.
COOPER, GEORGE T., Rutherford, N. J.
CRUMP, RALPH E., North Hollywood, Calif.
DESA, VALENTINE G., Dacca, East Pakistan
DONLEY, CARSON O., Indianapolis, Ind.
DREVER, J. ROSS, Clarendon Hills, Ill.
ELLWOOD, E. T., Tulsa, Okla.
EMERSON, R. W., Pittsburgh, Pa.
ESTES, JOHN C., Richland, Wash.
EVERS, EUGENE A., Los Angeles, Calif.
FOTIU, AREST G., Detroit, Mich.
GILLISON, RICHARD W., Berkeley, Calif.
GREEN, LEON Jr., Downey, Calif.
GULATI, PRAN NATH, Washington, D. C.
HESTER, L. A., Philadelphia, Pa.
HOGEMAN, HANS, Longmeadow, Mass.
HUFMAN, GEORGE H., Schenectady, N. Y.
JOHNSON, DONALD R., Flushing, N. Y.
KAUL, JOSEPH I., Toledo, Ohio
KAYLOR, J. WILLIS, San Francisco, Calif.
KEETON, JAMES E., Oak Ridge, Tenn.
KELLER, LOUIS V., Washington, D. C.
KENNEDY, RICHARD C., North East, Pa.
KINDL, FRED H., Alplaus, N. Y.
KLEE, MAURICE, Wheaton, Ill.
KOLAR, ANDREW K., Chicago, Ill.
KRAUSE, ELLSWORTH C., Baltimore, Md.
LADD, GEORGE T., Farmingdale, N. Y.
LAMBERSON, EDWARD E., Staten Island, N. Y.
LEDERMAN, MELVIN J., Stoneham, Mass.
MACLEOD, DONALD, St. Catharines, Ont., Can.
MASSELL, CHARLES B., Toronto, Ont., Can.
MATTISON, MILFORD Z., Oil City, Pa.
MCNEILL, DANIEL B., Kansas City, Mo.
MELZER, HOWARD H., Milwaukee, Wis.
MORLAN, ERWIN A., Houston, Texas
NICOL, WILLIAM B., Buffalo, N. Y.
NIELSEN, HAROLD, Dayton, Ohio
OGDEN, WILFRED J., Warwick, R. I.
PARADIS, ROGER A., Ottawa, Ont., Can.
PEACOCK, PAUL E., Jr., Westfield, N. J.
PECK, NELSON C., Oak Park, Ill.
PENTNEY, WILLIAM M., Buffalo, N. Y.
PHELPS, MAX M., Long Beach, Calif.
PINKUS, OSCAR, Albany, N. Y.
RALSTON, PETER, Wilson Heights P.O., Ont., Can.
REED, EDWARD A., Flint, Mich.
ROBITZ, ROBERT E., Atlanta, Ga.
SAMPFIELD, EDWIN, Parma, Ohio
SCHRANTZ, RICHARD N., Buffalo, N. Y.
SHAW, GEORGE F., Montreal, Que., Can.
SHERRY, JAMES T., New York, N. Y.
SINGH, ATMA, Meerut City, India
SIPPOLA, ALVIN I., New York, N. Y.
SMITH, CLYDE B., Chicago, Ill.
STRAUSS, KURT G., Los Angeles, Calif.
STUBBS, ELMER J., Cleveland, Ohio
TAUSKEY, RUDOLPH H., New York, N. Y.
TISDALE, LUCIAN E., Natchez, Miss.
URBACH, HARLEY J., Canton, Ohio
WILEY, JOSEPH B., Jr., Bedminster, N. J.
WILLIAMS, PAUL A., Moline, Ill.
ZIPPERER, J. C., Evanston, Ill.

### CHANGE IN GRADING

*Transfers to Member and Associate*

BETZ, ALLEN, New Orleans, La.
BLEDSOE, L. F., Jr., Newport News, Va.
BRANDT, ADOLF, Jr., Olmsted Falls, Ohio
CURTIS, JACK W., Santa Rosa, Calif.
DAVICH, MICHAEL, DeKalb, Ill.
DAVIS, A. SHERMAN, Jr., Houston, Texas
DUDLEY, JOHN H., Lancaster, Pa.
GRIMALDI, JOHN V., Floral Park, N. Y.
JANSSEN, EARL, Los Angeles, Calif.
JUDE, HENRY, New York, N. Y.
KOPF, WILLIAM F., Roselle, N. J.
LEDDY, JAMES E., New Orleans, La.
MEEKER, W. H., 4th Calcutta, India
MULLIN, WILLIAM H., Havertown, Pa.
NEBEN, ERNEST W., Rochester, N. Y.
RIEDEL, HARVEY J., Ridgefield, N. J.
SELMER, ALFRED P., Nanticoke, Pa.
SINTON, WALTER, Philadelphia, Pa.
STEWART, WILTON A., Nina Lake, Calif.
SWANTON, HAROLD R., Los Angeles, Calif.
TUTHILL, ELMER S., East Orange, N. J.
VARNUM, RICHARD S., Jr., Hilton Village, Va.
WILLIAMS, SAYRE S., San Diego, Calif.
WILTERDINK, PAUL I., Cleveland, Ohio
WITTENBERGER, WALLACE W., Franklin Park, Ill.

*Transfers from Student Member to Junior* . . . . 125

## Obituaries

### Ernest Hill Billipp (1882–1951)

ERNEST H. BILLIPP, who was retired in 1946 as vice-president and chief engineer, Turl Iron and Car Foundry, Newburgh, N. Y., died at his home in Rye, N. Y., June 8, 1951. Born, Boston, Mass., May 4, 1882. Parents, Ernest and Pauline F. Billipp. Education, high-school graduate; special courses. Mem. ASME, 1921. He devised automatic control devices for the Sugar Loaf Mountain Cable at Rio de Janeiro and was a technical adviser on several large electrical projects in Central and South America. He developed special tools during World War II to adapt 75-mm shells for use in both American and French guns. He also worked as an engineer on the construction of Stewart Air Field near West Point and other airfields. Survived by two sisters, Pauline E. and Mrs. Elsie Olfers; three brothers, Frederick Rudolph, and Casper.

### William Brown Brendlinger (1878–1951)

WILLIAM B. BRENDLINGER, mechanical engineer and district sales manager, Ingersoll-Rand Co., died June 26, 1951, at his home in Merion, Pa. Born, Bridgewater, Pa., Aug. 6, 1878. Parents, Peter Franklin and Hannah Taylor (Brown) Brendlinger. Education, BSME, University of Pennsylvania, 1900. Married Florence Wilbur Newton, 1906; children, Robert N. and Elizabeth B. Assoc. ASME, 1907.

### Howard Hall Bristol (1888–1951)

HOWARD H. BRISTOL, president and chairman of the board, Bristol Co., Waterbury, Conn., died June 2, 1951. Born, Naugatuck, Conn., Jan. 23, 1888. Parents, Franklin B. and Cora (Russell) Bristol. Education, ME, Stevens Institute, 1910. Married Alice H. Osborn, 1912. Jun. ASME, 1913; Mem. ASME, 1925. Survived by wife, two sons, Howard H., Jr., Tel Aviv, Israel, and Franklin E., Richmond, Va.; two daughters, Mrs. R. Norris Wilson, Chatham, N. J., and Mrs. George Hartland, Plainfield, N. J.; three brothers, Samuel R., and Carlton W., of Naugatuck, and Franklin B., Middlebury, Conn., and four grandchildren.

### Elton Shumway Brown (1900–1951)

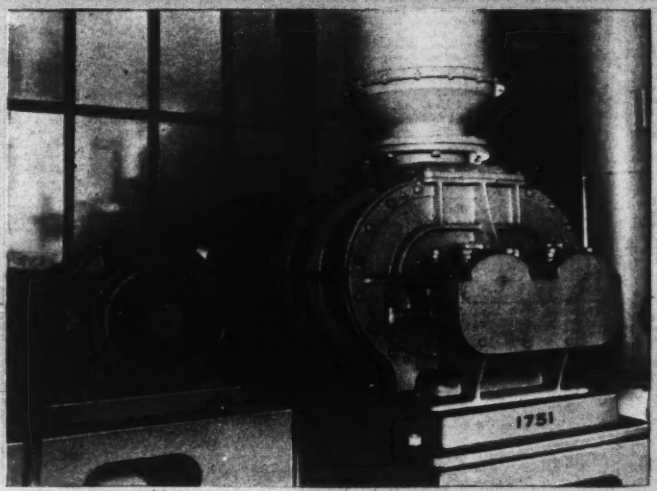
ELTON S. BROWN, manager, industrial sales department, Esso Standard Oil Co., Charleston, W. Va., died May 31, 1951. Born, Alderson, Pa., July 15, 1900. Parents, Miles Mason and Florence G. (Shumway) Brown. Education, BA, Harvard College, 1922. Married Nina Holt White, 1934; children, Patricia, Richard E., Benjamin W., and Robert L. Assoc. ASME, 1943.

### George Robert Graham Conway (1873–1951)

GEORGE R. G. CONWAY, director, Mexican Light and Power Co., Ltd., Mexico, D. F., Mex., died May 20, 1951. Born, Southampton, England, April 28, 1873. Parents, Henry and Jessie (Graham) Conway. Education, Tauntons School and Hartley University College, Southampton, England. Mem. ASME, 1913. He was awarded the Telford Gold Medal, Institution of Civil En-

(*ASME News continued on page 778*)

# NO V-P-L WORRIES WITH R-C BLOWERS




ROTARY

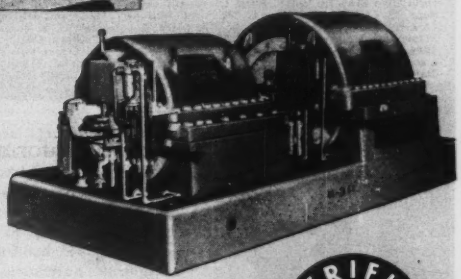
Rotary Positive Blower for pneumatic conveying in large eastern processing plant. Many other R-C units are used in various plants of this same company.

Today's production urgencies call for "no-vacation" performance from blowers and other equipment to move gas and air. You must be sure of positive Volume, at the required Pressure, and at Low power cost to keep down rising expenses. The answer is Roots-Connersville Blowers with V-P-L.

You obtain this freedom from worry whether you install R-C Centrifugal or Rotary Positive equipment. This exclusive *dual-ability* gives you the choice of either type to best meet your requirements. Wide latitude in sizes, from 5 cfm to 100,000 cfm, permits selection of units with capacities close to your specific needs. Often, this flexibility saves time, cost, space, weight and power charges.

R-C engineers will gladly counsel with you on any problem of moving or measuring gas or air to keep production going.

ROOTS-CONNERSVILLE BLOWER CORPORATION
510 Michigan Avenue, Connersville, Indiana



Two, 4-Stage, Type H Centrifugal Compressors, mounted on common base. Motor driven, with capacities of 11,230 cfm and 8,990 cfm, respectively.

CENTRIFUGAL

ROOTS-CONNERSVILLE

BLOWER BUILDERS SINCE 1854

ONE OF THE DRESSER INDUSTRIES

gineers, London, 1909. Author of several technical papers in the field of hydraulics and more than ten books on historical subjects. Survived by wife and son, Hugh G., Gloucester, England.

**Alvin Earl Dodd (1883–1951)**

ALVIN E. DODD, honorary president, American Management Association, New York, N. Y., died June 2, 1951. Born, Hudson, N. Y., March 11, 1883. Parents, Alvin Harvey and Edith (Merrill) Dodd. Education, BS, Armour Institute of Technology, 1905; hon. LLD, Temple University, 1948. Married Catherine Filene, 1921 (divorced 1930); daughter, Joan. Married 2nd, Henrietta F. Coster, 1941. Received Henry L. Gantt Gold Medal, 1947. Fellow ASME, 1946. Survived by wife, daughter, Mrs. David Robertson, Washington, D. C.; and a brother, Earl M., San Francisco, Calif.

**Fitzroy Lionel Eden (1882–1951)**

FITZROY L. EDEN, engineer, Raymond Concrete Pile Co., New York, N. Y., died at his home in Leonia, N. J., May 18, 1951. Born, Dover, England, July 28, 1882. Parents, Robert Charles and Annie (Bain) Eden. Education, Dr. Hawkins School; Stevens Preparatory School. Married Irene Starr, 1914. Mem. ASME, 1923. Survived by wife.

**Allan Ormsby Geertz (1900–1950)**

ALLAN O. GEERTZ, fuel engineer, coal traffic department, Pennsylvania Railroad, Philadelphia, Pa., died in the fall of 1950. Born, Montclair, N. J., Sept. 4, 1900. Parents, Julius Florentin and Jessie (Ormsby) Geertz. Education, MS, Cornell University, 1922. Married Ruth Allyne Martin, 1929. Mem. ASME, 1942. Survived by wife.

**Harold Robert Holm, Jr. (1924–1951)**

HAROLD R. HOLM, JR., mechanical engineer, U.S.A.F., engineering division, Air Materiel Command, Wright-Patterson A.F.B., Dayton, Ohio, was killed in an airplane crash, May 23, 1951. Born, Boston, Mass., July 11, 1924. Parents, Harold Robert and Dorothy M. (Ellis) Holm. Education, BSME, Northeastern University, 1949. Married Eleanor C. Nelson, 1949. Jun. ASME, 1949.

**Hiram Aiken Humiston (1893–1951)**

HIRAM A. HUMISTON, industrial sales engineer, lubricating-oil sales, Standard Oil Co., Cleveland, Ohio, died May 19, 1951. Born, Cleveland, Ohio, Sept. 7, 1893. Parents, C. B. and Martha (Aiken) Humiston. Education, 3½ years, University of Michigan. Married Mary Jane Fox, 1944. Assoc. ASME, 1946. Survived by wife and a son by a former marriage, Homer A. Humiston, Baltimore, Md.

**Dugald Caleb Jackson (1865–1951)**

DUGALD C. JACKSON, professor emeritus of electrical engineering, Massachusetts Institute of Technology, died July 1, 1951. His death followed by two weeks that of Edward L. Moreland, with whom he had been associated in the Boston consultant-engineering firm of Jackson and Moreland. Born, Kennett Square, Pa., Feb. 13, 1865. Parents, Josiah and Mary Detweiler (Price) Jackson. Education, CE, Pennsylvania State College, 1885; graduate study in electrical engineering, Cornell University, 1885–1887; hon. DS, Columbia University, 1932; hon. DE, Northeastern University, 1938. Married Mabel A. Poss, 1880. Mem. ASME, 1890; Fellow ASME, 1938; Hon. Mem. ASME, 1945. During the latter part of World War I he served as a lieutenant colonel of Engineers in France. In 1929 President Hoover named him as U. S. representative to the World Engineering Conference in Tokyo. He was a member, National Research Council, 1932–1936; member, board of investigation, Society for the Promotion of Engineering Education. He was a Chevalier, Legion of Honor, France; past president, American Academy of Arts and Sciences; fellow, American Philosophical Society, and a member of numerous engineering societies here and abroad. He was awarded the Lamme medal, SPEE, 1931; Edison medal, AIEE, 1938. He was the author of five books on electrical engineering and wrote approximately 150 papers on engineering and engineering education. During his long career he witnessed and participated in the development of the modern electrical industry. Survived by wife, a son, Dugald C., Jr., Fellow ASME; and a sister, Mrs. Louis B. Reber, West Palm Beach, Fla.

**Merrill William Jensen (1923–1951)**

MERRILL W. JENSEN, research engineer, Kiekhaefer Aeromarine Motors, Inc., Fond du Lac, Wis., died May 25, 1951. Born, Madison, Wis., Jan. 30, 1923. Parents, Severt M. and Mary C. Jensen. Education, BSME, University of Wisconsin, 1947. Married Elsie Jane Petersen, 1945. Jun. ASME, 1947. Survived by wife and two children, Patricia Lee and Thomas Alan; his parents and two brothers, Donald P. and Kenneth S.

**Alvin Frederick Knoblock (1872–1950)**

ALVIN F. KNOBLOCK, chairman of board, Bundy Tubing Co., Detroit, Mich., died Sept. 1, 1950. Born, Dresden, Germany, Nov. 3, 1872. Parents, Herman W. and Lina Knoblock. Education, Detroit and Albion College, Albion, Mich. Naturalized U. S. citizen, 1920. Married Jane Florence Pickard, 1901. Mem. ASME, 1914. Survived by wife and two children, Mrs. Frank B. Koepel, Detroit, Mich.; F. Delbridge Knoblock, Bloomfield Hills, Mich.

**Maxwell Carson Maxwell (1877–1951)**

MAXWELL C. MAXWELL, retired executive, Yale and Towne Manufacturing Co., and former works manager, Stamford division of the company, died June 13, 1951, at his farm in Cambridge, Md. Born, Washington, D. C., Dec. 18, 1877. Parents, Charles A. and Alice L. (Carson) Maxwell. Education, ME Cornell University, 1900. Married Nellie Cooke, 1902 (died 1934); children, Dorothy and Virginia. Married 2nd, Martha Carol Mayer, 1935. Mem. ASME, 1908; Fellow ASME, 1943. Served the Society as chairman, Committee on Relations with Colleges; member, Committee on Policies and Budgets. Survived by wife and two daughters, Mrs. John Zimmerman, Stamford, Conn., and Mrs. William H. Holding, Ridgefield, Conn.

**Edward Leyburn Moreland (1885–1951)**

EDWARD L. MORELAND, retired vice-president, Massachusetts Institute of Technology; partner, Jackson and Moreland, engineers, Boston, Mass., died July 17, 1951. Born, Lexington, Va., July 1, 1885. Parents, Sidney T. and Sally P. (Leyburn) Moreland. Education, BA, The Johns Hopkins University, 1905; MS, Massachusetts Institute of Technology, 1908. Married Francina C. Campbell, 1913. He was the author of several technical papers and served the U. S. Government as technical consultant during both world wars. Mem. ASME 1921.

**George Edward Riker (1905–1951)**

GEORGE E. RIKER, mechanical engineer, Hydrocarbon Research, Inc., New York, N. Y., died May 27, 1951, of a heart attack. Born, Bloomingdale, N. J., Feb. 5, 1905. Parents, Alfred C. and Lillian Riker. Education, 5 years, Pawcett School of Industrial Arts; 3 years, Seymour-Vocational School. Married Emma S. Williams. Mem. ASME, 1937. Survived by wife, a daughter, Mrs. William E. Rogers; three sons, Robert F., James W., and Paul R.; and his mother, Mrs. Charles Hammond.

**Stanton Edwin Tomkins (1918–1951)**

STANTON E. TOMKINS, instructor, mechanical-engineering department, University of Michigan, died June 15, 1951. Born, Phoenixville, Pa., April 17, 1918. Parents, Harland E. and Grace (Stull) Tomkins. Education, BS, The Pennsylvania State College, 1939; MSE, University of Michigan, 1949. Married Helen Louise Stark, 1943. Jun. ASME, 1939; Mem. ASME, 1950. Survived by wife.

**Guy Lane Warden (1888–1951)**

GUY L. WARDEN, power-equipment engineer, president, Guy L. Warden and Sons, Los Angeles, Calif., died June 14, 1951. Born, Washburn, Wis., Aug. 26, 1888. Parents, Alfred Martin and Helen (Murdock) Warden. Education, graduate, Washburn High School, 1905; ICS; ACS. Married Lyla C. Willey, 1911. Jun. ASME, 1916; Assoc. Mem. ASME, 1923; Mem. ASME, 1929. Past chairman, ASME, Southern California Section. Survived by wife, and four children, G. Lane, Jr., San Gabriel; Robert I., West Covina; John M., El Monte, and Helen I. Ward, Los Angeles, Calif.

## ASME Master-File Information

*(Not for use of student members)*

Please print — Check mailing address

Name ..... (Last, First, Middle)

Home address ..... ☐ (Street, City, Zone, State)

Name of employer .....

Address of employer ..... ☐ (Street, City, Zone, State)

Product or service of company .....

Title of position held .....

Nature of work done .....

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Transactions ☐ Journal of Applied Mechanics. ☐ Applied Mechanics Reviews ☐

*(Processing of address change requires four weeks)*

## Keep Your ASME Records Up to Date

HEADQUARTERS depends on its master membership file for answers to hundreds of inquiries daily pertaining to its members. All other Society records and files are kept up to date through changes processed through it. The listings in future ASME Membership Lists will be taken directly from the master file. It is important to you that it lists your latest mailing address and your current business connection.

Four weeks are required for complete processing of address changes.

The mailing form on this page is published for your convenience. You are urged to use it in reporting recent changes.

Your mailing address is important to Headquarters. Please check whether you want your mail sent to home or office address.

# ANOTHER PROMINENT BUILDING

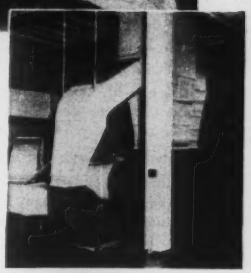
Served by "Buffalo"

## AIR CONDITIONING UNITS and FANS

### The Washington Post
BUILDING • WASHINGTON, D. C.

Washington Post Building, Engineer: Albert Kahn, Associated Architects and Engineers, Inc. Contractor: John McShain, Inc. Mechanical Contractor: Standard Engineering Co.

Clean, fresh air at right temperature and right humidity went into the planning of this famous and ultramodern newspaper building. Why? Because proper air control in a building directly affects the efficiency, morale and well-being of those working inside. This has been proven time and time again in factory, office building, store and, in fact, any place where people congregate. And "Buffalo" Fans, Pumps and Air Conditioning Units have been doing their jobs to such satisfaction that they have become a standard to many of the leaders in the construction and engineering fields. You are safe in recommending "Buffalo", the name you see in big installations throughout the world.



Above, a large "Buffalo" Air Washer supplying clean, properly tempered air at all times in the Washington Post Building. At left are two of the large "Buffalo" Limit-Load Fans keeping air circulating throughout the building.

### AIR—Vital to Defense

Thousands of "Buffalo" Fans, Pumps and Air Conditioning Units are today rendering valuable service in every essential industry, from aircraft to textiles, in mines and on shipboard—helping the worker, bettering the product, operating 24 hours a day with little attention. Full details on any unit on request.

Above right, three other "Buffalo" Fans ventilating the 7-story building: left, a small Belted Vent Set and right, two medium sized Limit-Load Fans.

"Buffalo" FIRST FOR FANS

## BUFFALO FORGE COMPANY

148 MORTIMER ST. BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont. Branch offices in all Principal Cities

VENTILATING FORCED DRAFT | AIR WASHING COOLING | AIR TEMPERING HEATING | INDUCED DRAFT EXHAUSTING PRESSURE BLOWING

# JENKINS PRACTICAL PIPING LAYOUTS 57

## How to plan
## CONNECTIONS FOR COMMONLY USED TYPES OF METERS

**In practically all industries** meters are used to compute, accurately and automatically, the amount of flow. Fluids measured may be liquid, gas, or vapor (water, oil, gasoline, fuel gas, steam). Diagrams show the basic piping hookups for some of the more commonly used meters.

**Orifice Type** — generally used to indicate, totalize, and record moderate quantities of liquids, gases, or vapors.

**Venturi Type** — also indicates, totalizes and records. It is frequently used on condenser water supply units in power stations, water pumping stations, and sewage plants.

**Area Flow Type** — or Rotameter is for indicating, principally, in lines carrying fluids in moderate quantities.

**Displacement Meter** — usually totalizes only; this is the type used to measure water supply from city mains to buildings.

**Valve recommendations** include bronze, for ordinary service, and stainless steel where corrosive liquids are handled. Jenkins Fig. 106-A Bronze Globe is especially suited for shut-off service as recommended in these hookups. Jenkins All-Iron Valves are also available where desired.

Consultation with meter manufacturers is recommended to determine the type best suited for your particular service.

### A CHOICE OF OVER 500 VALVES

To save time, to simplify planning, to get all the advantages of Jenkins specialized valve engineering, select all the valves you need from the Jenkins Catalog. It's your best assurance of *lowest cost in the long run*. Jenkins Bros., 100 Park Ave., New York 17; Jenkins Bros., Ltd., Montreal.

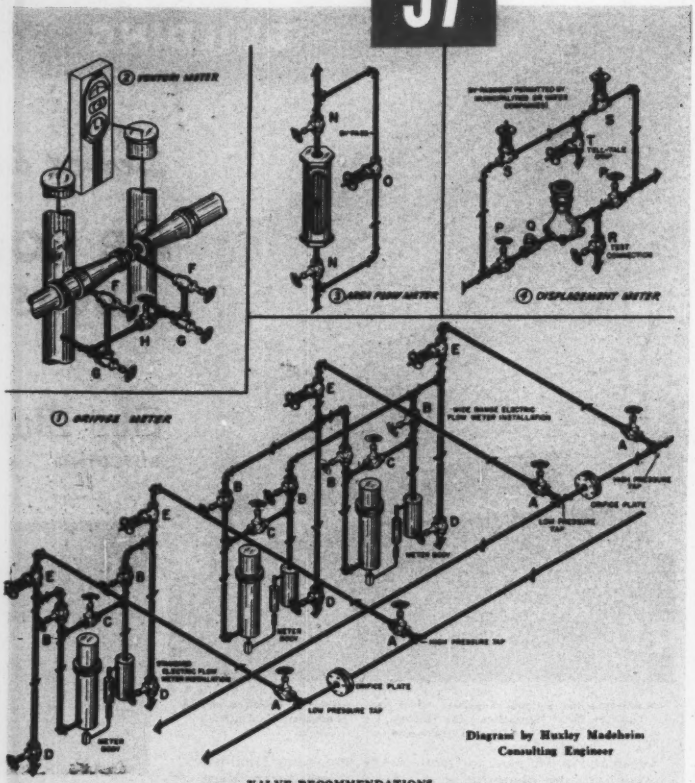



Diagram by Huxley Madeheim
Consulting Engineer

**VALVE RECOMMENDATIONS**

*For details of valves to suit varying conditions see Jenkins Catalog.*

| | JENKINS VALVES | | | | | |
|---|---|---|---|---|---|---|
| | Code | Quan. | Bronze | Stainless | | Service |
| ORIFICE METER | A | 4 | 106-A | 1308 | Globe | Orifice Tap Shutoff |
| | B | 6 | 106-A | 1308 | Globe | Meter Body Shutoff |
| | C | 3 | 741-G | 1308 | Globe | Equalizing Line |
| | D | 4 | 106-A | 1308 | Globe | Drain & Blow Down |
| | E | 4 | 47-U | 1302 | Gate | Main Shutoff or Meter |
| VENTURI METER | F | 2 | 108-A | 1310 | Angle | Piezometer Tap Shutoff |
| | G | 2 | 108-A | 1310 | Angle | Tap Shutoff to Water Cock |
| | H | 1 | 741-G | 1308 | Globe | Equalizer |
| AREA FLOW METER | N | 2 | 106-A | 1308 | Globe | Meter Shutoff |
| | O | 1 | 47-U | 1302 | Gate | By-Pass |
| DISPLACEMENT METER | P | 2 | 47-U | 1302 | Gate | Meter Shutoff |
| | Q | 1 | 92 | 1328 | Check | Anti Back Flow |
| | R | 1 | 106-A | 1308 | Globe | Test Connection |
| | S | 2 | 47-U | 1302 | Gate | By-Pass |
| | T | 1 | 47-U | 1302 | Gate | Tell Tale Drip |

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Jenkins Bros

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# • Keep Informed . . .

**These announcements are obtained mostly from advertisers in MECHANICAL ENGINEERING and ASME MECHANICAL CATALOG**

• NEW EQUIPMENT
• BUSINESS CHANGES
• LATEST CATALOGS

**Available literature or information may be secured by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.**

## • NEW EQUIPMENT

### New Small Thread Inserts

Four new small-size stainless-steel helical-wire thread inserts, for strengthening tapped threads in aluminum, magnesium, plastic, iron, steel, brass, bronze, and wooden components, are available from the Heli-Coil Corp., Danbury, Conn., in addition to its regular line of National Coarse, National Fine, spark-plug, and pipe-thread sizes.

These new sizes, extending the use of Heli-Coil thread inserts in small holes, include 8–36 and 6–40 sizes in the fine-thread series, 5–40 and 4–40 sizes in the coarse-thread series, and are available in 1, 1½, and 2-diam lengths.

Standardization of these new insert sizes was stimulated by the needs of household-appliance and business-machine manufacturers for small-size antistripping, antiabrasive and anticorrosive threads in the housing of sewing machines, vacuum cleaners, adding machines, typewriters, and other units.

Installation of helical-wire thread inserts in either small components or heavy-industry castings accomplishes the same results—stronger and more durable threads. Insert-lined holes withstand substantially higher loads than unprotected holes. Threads in these holes are more resistant to wear, corrosion, seizing, and galling.

### Fork-Lift Trucks

A number of new features have been incorporated in the 4000 and 5000-lb electric Carloader fork-lift trucks, which are claimed to provide easier operation, greater safety, and improved maneuverability, according to the maker, Clark Equipment Co., Battle Creek, Mich.

Operation is simplified by mounting the "fingertip" control lever on the steering column. This makes possible the selection of direction of travel and the engagement of the first point of power simultaneously.

Automatic acceleration eliminates jerky movement. Shifts from one point of power to another are timed automatically in accordance with torque requirements.

Steering is made easier by means of the "no-kick-back" steering axle which is pivoted on rubber torsional bearings.

An added factor of safety is provided by a "deadman" brake which is linked to the driver's seat and operates off the drive shaft of the drive motor. The brake is set automatically the instant the driver's seat is unoccupied.

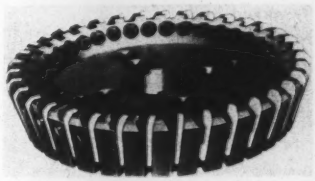
Improved design of these late models provides for greater maneuverability because of the smaller turning radius. Higher traveling speeds as well as faster lifting speeds are also attained.

The battery compartment has been completely redesigned for greater convenience. The top cover is hinged at center to permit charging and servicing battery without removal from truck, and is also quickly removed so battery can be lifted out.

### Axial-Face Mill

Kennametal Inc., Latrobe, Pa., has introduced a simplified axial-face mill, style MF Kennamill, having wedged-in solid Kennametal blades and structural features that make possible removal of cast iron at from 60 to 70 in. of table travel per min. It is suitable for both general purpose and high continuous production milling.

This mill has only four parts: Body, blades, wedges, and nuts. Wedges and screws are one-piece high-alloy steel, hardened and ground to close tolerances; they remain assembled to the cutter body at all times, thus reducing the possibility of "lost" parts.

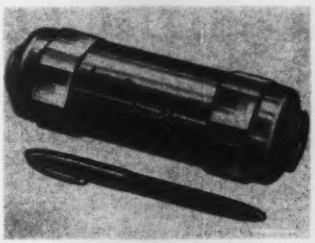


The blades, which are the same as those used in previous design of cast iron cutters, are heavy, solid, wedged-in—thus no brazing strains. No hammers or special tools are needed to tighten them—a simple hex wrench suffices—thus breakage and wedge distortion are minimized. Blades are available in two styles—for cutting to a square shoulder or to a 45-deg corner. They are interchangeable in all slots of any size of cutter body of the same type. Wedges are round and they are interchangeable in any slot of any size cutter, either right or left hand. They do not have to be pried out, but can be readily loosened with a soft hammer.

The new face mill is made in seven cutting diameters: 6, 8, 10, 12, 14, 16, and 18 in.; either right or lefthand. Specifications and prices are available in Catalog 51 which can be obtained from the manufacturer.

### Surge Damping Valve

New surge damping valves, said to eliminate excessive shock in high-pressure hydraulic systems, have been developed by the Denison Engineering Co., Columbus, Ohio. They are an individual unit universally adaptable to any hydraulic circuit. Both aviation and industrial models are available in a range of sizes for wide application.



Small and compactly designed, they are installed as easily as any ordinary fitting and do not interfere with other functions of the circuit. The valve has been proved in test setups over many months to successfully prevent shock from occurring, rather than simply absorb hydraulic surge and consequent shock.

Possible application for this surge damping valve are reported to include installation at the ports of 4-way valves; in a cylinder circuit as an automatic decompression valve; in any line leading from an accumulator; and in other locations.

### Autometer

The Thomas Autometer—manufactured by Leeds & Northrup Co., Philadelphia, Pa., for fully automatic analysis and recording of air pollution by $SO_2$—is now available as either an integrating or nonintegrating assembly, complete with Speedomax electronic recorder.

Range of the equipment—0 to 5 parts $SO_2$ per million—covers the concentrations which are of interest in pollution surveys. Changes in concentration as small as a few tenths of a part per million can be readily detected.

Unlike most gas analyzers, the Autometer makes use of electrolytic conductivity as a means of measurement. A continuous sample of air is passed through a solution which absorbs $SO_2$, causing a change in the electrolytic conductivity of the solution.

For further information write to Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

*Continued on Page 43*

# ELIMINATE MOTOR FAILURE with class (H) insulation made with DOW CORNING SILICONES

## Wet Motors

are a constant threat to your production schedules . . . unless they're wound with Dow Corning Silicone (Class H) insulation. Here's evidence of the fact that Class H has at least 10 times the wet insulation resistance of the next best class of insulating materials. At Virginia-Carolina Chemical Corporation's Homewood mine, a 300 hp., silicone insulated motor was back in service 3 hours after flooding with mud and waste water. Under the same conditions, an identical Class B motor had to be reworked and rebaked. Similar experience over the past 5 years has persuaded many chemical companies to specify Class H exclusively for all condensate and centrifugal pump motors.

## Hot Motors

die young . . . unless they're protected with Dow Corning Silicone (Class H) insulation. Here's evidence of the fact that Class H insulation makes hot and hard working motors last 10 times longer than they ever did before. Silicone insulated spinner bucket motors in rayon mills last 6 to 24 times as long as Class A motors. Silicone insulation makes the high speed, rapidly reversing motors used by Cogsdill Twist Drill Company last 12 to 100 times as long as Class A or Class B motors. In a large steel mill, a crane hoist motor had 4 to 42 times the life of a Class B motor.

## Keep 'em running with Dow Corning Silicones

Write today for list of Class H motor manufacturers or listing of Class H rewind shops now located in all major industrial centers.

Address Department Q-9

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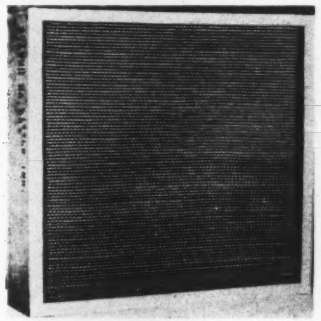
## • Keep Informed

### Absolute Air Filter

An absolute air filter, developed originally for the Atomic Energy Commission and capable of removing better than 99.98 per cent of all dust, smoke, fumes, radioactive particles, spores, and other microsopic foreign matter from the air, is now being produced in quantity for commercial use, it was announced by Cambridge Corp., Syracuse, N.Y., a company jointly owned by Carrier Corp., Syracuse, N. Y., and Arthur D. Little, Inc., Cambridge, Mass.

The new filter is especially applicable wherever absolutely clean air is needed for processing, or where toxic or radioactive fumes or dust must be prevented from escaping to the atmosphere or from entering working areas or shelters, the company stated.

The filter is being manufactured at present in two standard sizes with rated capacities of 500 and 850 cfm of air. Individual units may be arranged in multiple banks of filters in built-up ventilating or exhaust systems or central station air-conditioning systems to handle any desired amount of air.



The filtering material is a soft, feltlike paper made of specially treated pulp containing very fine asbestos fibers. The paper is folded and packed into the filter in an accordion pleat arrangement to provide an extensive filtering area within a small space. Dimensions of the filters are 24 × 24 × $5^{7}/_{8}$ in. deep for the 500-cfm size and 24 × 24 × $11^{1}/_{2}$ in. deep for the 850-cfm size.

Inquiries should be directed to Cambridge Corp., 350 South Geddes St., Syracuse, N.Y.

### Heating and Ventilating System

By literally building the elementary school for Hillsborough Township, Somerset County, N. J., "around" a direct-fired warm-air heating and ventilating system, the entire installation cost about 30 per cent less than a "wet" system for the same structure. Total cost of the system amounted to approximately 81 cents per sq ft of the building. Installed cost of the heating and ventilating system was less than 7 per cent of the total cost of the building including landscaping, site development, kitchen equipment, and all other essentials except furniture for classrooms.

With the system used, every room in the building—there are 14 classrooms, plus offices, clinic, library, rest rooms, kitchen, and a combination cafeteria-assembly hall—is supplied with a constant volume of 100 per cent fresh, filtered outside air during school hours. A unique and inexpensive method of blending hot and cold air as it enters each room solves the problems of

*Continued on Page 44*


New di-acro POWERSHEAR

OFFERS CONTINUOUS ACTION plus VARIABLE SPEED

from 30 to 200 strokes per minute

for high speed DIE-LESS DUPLICATING

The new Di-Acro POWERSHEAR has remarkable speed and accuracy for the production of small parts.

1. CONTINUOUS SHEARING ACTION— no clutch to engage! Feeding speed determines shearing speed.
2. VARIABLE SPEED — cycle quickly set for each shearing operation.
3. EASE OF OPERATION — fatigue is reduced, production soars.
4. "SINGLE STROKE" SHEARING — non-repeating safety clutch for jobs not adaptable to continuous shearing.

Any plant doing high speed precision shearing on smaller parts cannot afford to be without the DI-ACRO POWERSHEAR. Available in 12" and 24" shearing widths, capacity 16 gauge sheet steel. Also standard model.

DOES PRECISION WORK ON ALL SHEARABLE MATERIALS

| | | | |
|---|---|---|---|
| MICA | LEATHER | ALUMINUM | STAINLESS STEEL |
| PLASTICS | SILVER | SILICON STEEL | and Many |
| BIMETALS | MAGNESIUM | CHROME MOLY | Other Materials |
| FIBRE | COPPER | LEADED BRASS | |

SEND FOR 40 PAGE "DIE-LESS DUPLICATING" CATALOG giving full details on Di-Acro Powershears, also Di-Acro Benders, Brakes, Rod Parters, Notchers, Rollers and Punches.

DI-ACRO DIE-LESS DUPLICATING

O'NEIL-IRWIN

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Is Space an Important Factor?

Then Use This Distinguished Line of Close-Coupled Pumps

These GMC Pumps are ideal for a multitude of jobs. Smooth and efficient whether vertical, horizontal, up-side-down or any inclination. Low first cost, low power and maintenance costs. Top quality "by Aurora."
PUMPS by Aurora
Caps. 10 to 800 G.P.M.
Heads to 250 Ft.
Type GMC
Aurora Close-Coupled Pump
Write TODAY for CONDENSED CATALOG "M"
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MATERIAL HANDLING *News*

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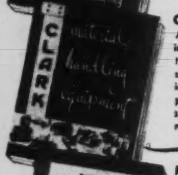
Cartoons and a light touch sell the idea that safe operation and good care of materials-handling equipment pay off for company and operator. Pocket size. Available in quantity.

**BASIC FACTS**
For a clear understanding of modern handling principles and practices, have your entire staff read this one. Pocket size.




**CONDENSED CATALOG**
A complete, compact showing and basic specifications of the Clark Leadership Line—fork-lift trucks, industrial towing tractors, powered hand trucks and special handling attachments.

**MOVIE DIGEST**
Clark movies enable you to see at your convenience modern machines in action. Synopses of films widely rated "the best in the materials-handling field," and how to borrow them.

These up-to-date publications will prove exceedingly valuable in cutting your handling costs and in getting the utmost benefit from your equipment. They are yours for the asking—any or all of them. Simply use the coupon.

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## • Keep Informed

temperature control. This takes care of temperature fluctuations caused by solar heat gains, lighting fixtures, and the sensible heat given off by classroom occupants. Furthermore, it is not necessary to open windows or doors for ventilation, a practice that creates unhealthy drafts.

One main problem confronting the designers was how to warm sufficient volumes of outdoor air for the ventilating requirements which, in a school building, are a vital consideration. This problem was overcome by the use for the entire system of two "Counterflo" direct-fired space heaters, each having an output capacity of 1,750,000 Btu per hr, and made by Dravo Corp., Pittsburgh, Pa. Equipped with stainless-steel combustion chambers and having high thermal efficiency, these two units handle the job of heating some 20,000 cfm of outdoor air for the completely automatic heating-ventilating system.

### Eight-Ton Self-Contained Air Conditioner

The 8-ton SU-81 is the newest and largest self-contained air conditioner to be added to the Westinghouse SU Unitaire line of within-the-space conditioners. The 8-ton SU-81—like the 2-ton SU-21, the 3-ton SU-31, and the 5-ton SU-51—is designed specifically to provide comfortable living and working conditions during the summer in homes, factories, offices, and other commercial establishments by cooling, dehumidifying, circulating, and filtering the air. All-year-round air conditioning can be provided by addition of either steam or hot-water heating coils and an outside air duct connection for ventilation air supply.

The SU Unitaire is a factory-assembled packaged air-conditioning unit that is complete in every detail: hermetically sealed Freon-12 compressor, water-cooled condenser, direct-expansion coil, and centrifugal fan. It is easy to install, requiring only water, drain, and electrical connections to place it in service.

The SU Unitaire air conditioner comes in four sizes: 24,000, 36,000, 60,000, and 96,000 Btu per hr with a 2, 3, 5, and 7½-hp compressor respectively. It can be provided for single, two, or three-phase operation on 50 or 60-cycle service. Voltage ratings on the units range from 230 volts on single-phase to 550 volts on three-phase.

For further information write to Westinghouse Electric Corp., Sturtevant Div., 200 Readville St., Hyde Park, Boston 36, Mass.

### Copper Plating Roller Chain Pins

Four advantages are claimed by Baldwin-Duckworth Division of Chain Belt Co., Milwaukee, Wis., as a result of their present method of copper-plating roller chain pins:

1 Copper Plating Assures Optimum Hardness for the Pins. Copper on the pin ends permits case hardening of the bearing surface of the pin to the optimum degree yet retaining soft ends. The file hard surface thus acquired assures longest pin life.

2 Copper Plating Assures Uniformly Good Riveting. Since copper won't absorb carbon during heat-treatment, pin ends remain relatively soft, permitting more secure riveting. Soft ends permit "upsetting" of pins, end in side plate, assuring the superior tight fit that eliminates any possibility of pins rotating in plate.

3 Copper Plating Assures Greatest Holding Power of Pins. Properly riveted pins have greater holding power than cottered pins. Soft pin ends assure highest quality riveting. No "weak links" in the chain caused by poor riveting.

*"Rudolph Says He Knows The Taps Would Last Longer If He Had The Right Cutting Fluid On The Machine"*

USE OF the *right* cutting fluid for the job *makes taps last longer,* conserves critical tool steel, minimizes downtime, increases output. A typical example:

A large instrument manufacturer changed to Stuart's THREDKUT for tapping Allegheny metal . . .

| | Before Using ThredKut | After Using ThredKut |
|---|---|---|
| Tap Life | 2 hours | 8 hours |
| Production | 180 holes per hour | 400 holes per hour |

You just cannot ignore the fact that the cutting fluid used is a major factor in any machining operation. A Stuart Representative is prepared to show you how Stuart combines theory and practice to give you better operating performance. Ask to have him call.

*Are you receiving Stuart's Shop Notebook regularly? Write, wire or phone*

CONSERVE TOOLS
Use the Right Cutting Fluid

STUART SERVICE
*Goes with every Barrel*

D. A. Stuart Oil Co.
2741 S. Troy St., Chicago 23, Illinois

For
TOP EFFICIENCY
INSULATED
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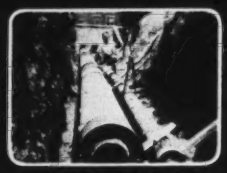
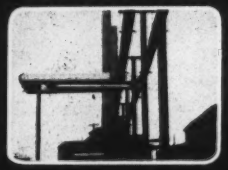


UNDERGROUND
OR
OVERHEAD



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*is your*
BEST CHOICE

For distribution of steam or hot water, oils or process liquids, Ric-wiL Prefabricated Insulated Piping will provide your piping system with maximum sealed-in protection and efficiency.

Architects, engineers, and contractors have long recognized the reliability of Ric-wiL engineering and manufacturing of high-efficiency insulated piping—factors that insure long trouble-free life of industrial, commercial, and residential piping systems.

THE RIC-WIL COMPANY
CLEVELAND, OHIO

Ric-wiL
PREFABRICATED
INSULATED PIPING
UNDERGROUND
OR OVERHEAD

## • Keep Informed

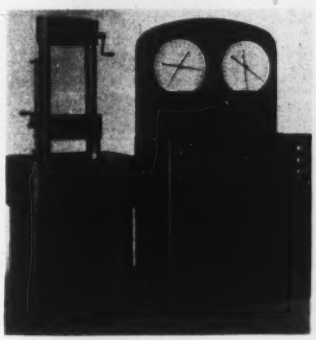
4 Copper Plating Permits Easy Chain Cutting. The comparatively soft pin heads can be easily ground off prior to driving out the pins or pin links. Thus, if disassembly is necessary, it is quick and easy.

Briefly, the pins are treated as follows: After cutting, machining, rough grinding, and tapering of the pin ends, the pins are entirely copper plated in a copper solution bath. Next, copper is ground off the shank of the pin, leaving only the two extreme outer parts of the pin body and the pin ends still plated.

Since copper does not absorb carbon, in the case-hardening operation, only the body of the pin (the bearing area or working surface in the assembled chain) absorbs carbon. This leaves the pin ends comparatively soft. The body of the pin is then given a finish grind and the pins are ready for assembly. The copper pin end is riveted to the side plate—the softened end makes for a firmer, stronger rivet.

### 12,000-lb Testing Machine

An improved, low-cost universal testing machine of 12,000 lb capacity is announced by Baldwin-Lima-Hamilton Corp., Philadelphia, Pa. The new Model 12-H, like the 60-H announced more than a year ago, has many of the features of larger Baldwin testing machines. One is that the hydraulic loading unit is separate from the indicating and control unit, which isolates recoil from breaking test specimens and permits adjusting maximum or lazy hands with minimum drag.



An exceptionally rigid, two-column design with 9½ in. of clear lateral space between columns gives high accessibility in handling specimens and simplifies observations. Load (either in tension or compression) is applied upward by an integrated piston and elevating cage consisting of the table, two uprights, and upper gripping head, all of which have an 8-in. stroke. Loading speed can be varied infinitely between 0 and 10 ipm.

Two ranges are provided. The 12,000-lb range is graduated in 20-lb units on a 16-in-diam indicator dial and a 3000-lb range is graduated in 5-lb units. Ranges other than standard—600 lb, 1200 lb, 2000 lb, and 6000 lb—are available in any dual combination.

### Sandblast Unit

A new handy soundblast unit, recently announced by The W. W. Sly Mfg. Co., Cleveland, Ohio, has a wide application for cleaning dies, tools, pistons, piston rings, valves, and other small parts.

It can be used with soft abrasives, such as ground corn cobs or nut shells, or with hard

*Continued on Page 48*

"I'm a
BOEING
engineer!"

You'll say that with pride. Men who can meet Boeing engineering standards share the prestige of leadership. They are doing vitally important work in the most challenging of all fields.

Boeing's Engineering Division has been growing steadily for 35 years. Today, it offers extraordinary career opportunities for the following:

**Experienced and junior aeronautical, mechanical, electrical, electronics, civil, acoustical and weights engineers for design and research; servo-mechanism designers and analysts; and physicists and mathematicians with advanced degrees.**

Here, at Boeing, you'll find stability and opportunity. You'll face the challenge of working on such vital programs as the B-47 and B-52 jet bombers, guided missiles and other revolutionary developments. Openings are available at both Seattle and Wichita. Your choice of location—the Midwest or Pacific Northwest. You'll enjoy good salaries that grow with you, and Boeing provides a moving and travel expense allowance.

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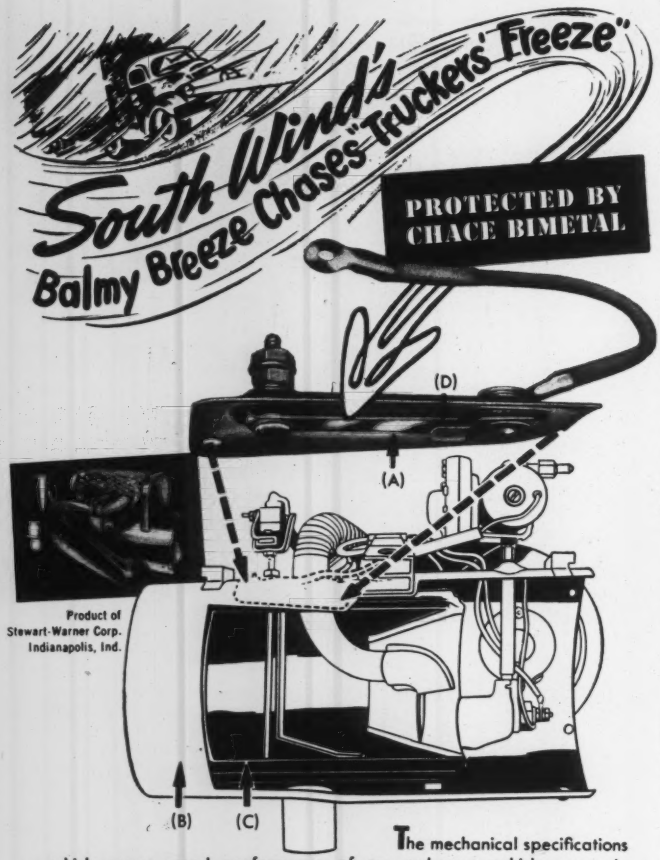
**Boeing Airplane Company, Seattle 14, Wash.**

Engineering opportunities at Boeing interest me. Please send me further information.

*Name* _____

*Address* _____

*City and State* _____




The mechanical specifications which assure good performance of our ordnance vehicles even in Aleutian frigidity might be completely nullified by the frailty of the human system. In a word, a frozen trucker can't turn a switch. But Stewart-Warner's South Wind Model 978 puts an end to this hazard with this compact, light weight heating unit designed to produce a maximum heat output of 20,000 BTU per hour. Naturally, it accomplishes this quickly, with utmost serviceability and, of course, safety.

Speaking of safety, Chace Thermostatic Bimetal plays an important part in the safety requirements for such a combustion type heater. The bimetal blade (A) is placed so that the ventilating air flowing between the heater case (B) and heat exchanger (C) also passes over the bimetal. If the ambient temperature, the temperature of the ventilating air, exceeds 250 degrees, the bimetal element deflects upward and breaks the circuit. As the contact (D) is broken, the shut-off solenoid of the fuel control valve stops the flow of fuel until the cause of the over-heating is removed or corrected.

Stewart-Warner fabricates this simple element from one of the 29 types available in strips, random length coils or completely fabricated elements. For a complete treatise on the selection and design of elements for your temperature actuated devices, ask for our 64-page booklet. But before you proceed with actual design or tooling, consult the Chace Application Engineers.

W. M. CHACE CO.
Thermostatic Bimetal
1619 BEARD AVE., DETROIT 9, MICH.
IT BENDS WITH THE HEAT

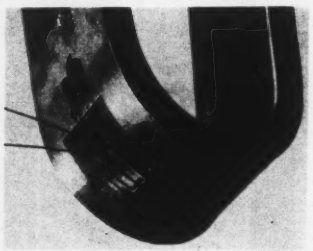

## • Keep Informed

abrasives such as sand, aluminum oxide, steel grit or shot. Soft abrasives will remove surface impurities without cutting into metal. Hard abrasives will clean and prepare surfaces for any kind of coating.

This unit is designed to be placed on a workbench, connected to a compressed air line and to a 110-volt lighting circuit. It has two lighting fixtures and an exhaust fan with large dust bag for making the operation dustless. Two armholes with rubber sleeves and gloves permit the operator to handle the work under the blast gun. The cabinet can be operated from a standard 5-hp 2-stage garage compressor.

### Post-Yield Strain Gage

Strains up to 10 per cent in materials or parts can be measured accurately by means of a new SR-4 "Post-Yield" strain gage announced by Baldwin-Lima-Hamilton Corp., Philadelphia, Pa. The new strain gage, identified as Type PA-3, enables measurement of strains far beyond the range of other SR-4 bonded resistance wire strain gages.



The new PA-3 strain gage has a flat-grid paper-base construction and requires a special air-drying cement which is supplied with it along with instructions for application. It has a resistance of 120 ohms, gage factory of 2.0, gage length of $^{13}/_{16}$ in., and minimum trim width of $^{15}/_{32}$ in.

### Starting Jet Fighters

Starting jet engines by "artificial respiration" has been tested successfully in Korea, the General Electric Co., Schenectady, N.Y., disclosed recently.

The method in which exhaust blast from one jet is used to start another directly behind it, was described by the company's Aircraft Gas Turbine Divisions and concurred by the Air Force as "an apparently practical means of starting jet aircraft at advance bases where external power units are unavailable, or in extremely cold weather where effectiveness of such starting sources is reduced."

Jet aircraft usually rely upon field power units for starting, rather than their own electric systems, because of the large amount of power required.

The Korean tests were conducted with North American F-86 fighters.

It was reported that the tailpipe of the operating jet was aligned directly in front and some distance ahead of the air intake of the plane to be started. The interval was selected to protect the pilot and airframe of the aircraft to be started from the high-temperature exhaust gases of the plane ahead. The pilot wore an oxygen mask as an added protection in the initial test.

When the engine of the lead plane was accelerated to full power, the exhaust blast was sufficient to windmill the power-plant of the idle aircraft to more than initial firing speeds and a normal start was made.

## • Keep Informed

### Forced-Draft Fan

Latest development of the Prat-Daniel Corp., East Port Chester, Conn., is a forced-draft fan embodying many new features that improve aerodynamic characteristics and more efficient conversion of velocity to static pressure.

Claims of the company set forth three improved features: (1) large, deep inlet cones streamlined to reduce turbulence at the inlet; (2) open space between the wheels of double-wheel models, instead of a common center disk, permitting complete four-way diffusion of the air leaving the wheels; and (3) an oversize housing to assist diffusion.

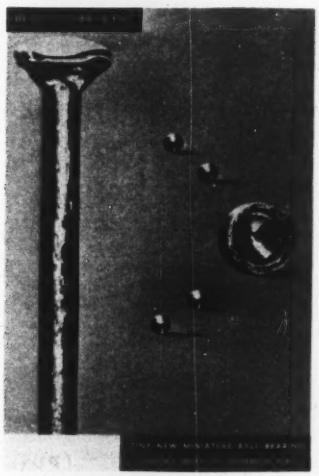
These features provide a more complete conversion of velocity pressure to static pressure, and make possible the higher efficiency of these fans.

Plotted performance shows peaks of efficiency and horsepower curves falling well within the proper fan selection range, making possible selection for maximum efficiency without overloading.

Inquiries for Bulletin 300, which describes the new fan, should be addressed to The Thermix Corp., Greenwich, Conn., project and sales engineers for Prat-Daniel.

### Miniature Ball Bearings

What is claimed to be the smallest pivot ball bearing made in America, has been announced by Miniature Precision Bearings, Inc., Keene, N. H. This new ball bearing has an outside diameter of 1.5 mm. It is the latest addition to the company's series of miniature pivot bearings. Diameter tolerance is held to plus zero and minus 0.0002 in.



To achieve these tolerances, measurements are made with instruments accurate to 20 millionths of an inch. The pivot shaft holds the balls in place. The raceway wall itself is designed so that its mass occurs at points of greatest strain. This permits relatively heavy loads under severe conditions of shock and vibration. These miniature ball bearings are rapidly replacing jewel bearings for instruments used under such conditions.

Uses for these miniature bearings include various precision instruments, textile rollers, servomechanisms, gyros, transits, fishing reels, etc.

*Continued on Page 48*

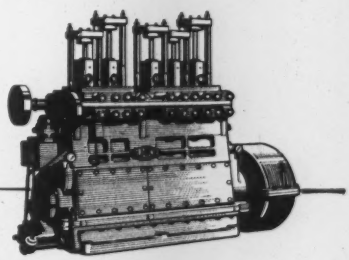
you take the high road

It's the short way home . . . when the high road means a straight line and a through-flow of traffic. It means too that you can get more work done today . . . and still more tomorrow.

Designed to give virtually the same results, the Aldrich Direct Flow Pump passes liquid directly through the working barrel. Aldrich design engineers have successfully eliminated two right angle turns in the fluid-end block.

The design, resulting in a reduction of "loss space", means more work done at less cost. Volumetric efficiency is improved and materials are saved. In each size, you get a lighter, more compact pump that does the same work better . . . which is why more people are coming to Aldrich for pumps made in 3″, 5″, 6″ triplex; 5″, 6″ quintuplex and 5″, 6″ septuplex units . . . to meet medium-to-high pressure and capacity requirements.

Applications where Aldrich Direct Flow Pumps are operating today include: hydraulic systems for press operation; plastic and rubber molding and extrusion; steel mill descaling, and other uses in the petroleum and chemical industries. Request Data Sheet 64.



THE ALDRICH PUMP COMPANY

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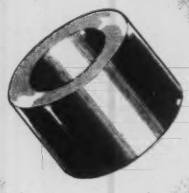
WORKS WHERE OTHERS WON'T



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SPECIFY GRAPHALLOY TRADE MARK REG. U. S. PAT. OFF. WITH CONFIDENCE

SELF-LUBRICATING ● EXTREMELY DURABLE ● CONSTANT CO-EFFICIENT OF FRICTION ● OPERATES DRY — OR SUBMERGED IN WATER, GASOLINE OR CORROSIVE LIQUIDS ● APPLICABLE OVER A WIDE TEMPERATURE RANGE — even where oil solidifies or carbonizes ● EXCELLENT AS A CURRENT-CARRYING BEARING.

GRAPHITE METALLIZING CORPORATION

1058 NEPPERHAN AVENUE, YONKERS 3, NEW YORK

## • Keep Informed

### Stoker Hoppers

The Iron Fireman Mfg. Co., of Cleveland, Ohio, announces that its deluxe commercial hopper model stokers have been refined to permit easier filling of the hopper and to avoid interference with boiler flue cleaning doors. Height of the hopper has been lowered and it is now fully open and sloping on the top, added to the compactness and efficiency of design.

Iron Fireman makes these hoppers in two sizes designed for use in warm air, steam, or hot water systems and industrial applications. For details write the company for descriptive bulletin.

### Boring and Turning Mill

The largest vertical boring and turning mill ever built in the United States was completed recently by Baldwin-Lima-Hamilton Corp., Hamilton, Ohio. The new Niles machine has a maximum swing of 43 ft 5 in. with a table of 33-ft diam, and a maximum height under tools of 12 ft 2 in. Total length over the operator's platforms at each end of the crossrail is 65 ft, total height over-all is 25 ft, and the bed extends 9 ft 6½ in. below the top of the table.

The 1,250,000-lb machine is being shipped to Officine Di Savigliano, Turin, Italy, where it is to be used primarily for turning parts for water-power generators and turbines, it is reported. The use of the machine was recently investigated and approved by the Economic Cooperation Administration and the State Department.

The table, which is 3 ft thick and had a rough weight of 267,900 lb, is made in three sections to facilitate shipment. Two similar segments 11½ ft wide are bolted, tongued and doweled to a center section 10 ft wide. The table is rotated by a 20-deg helical gear approximately 24 ft in diam. This gear, which has 288 teeth of one diametral pitch, was cast in halves and joined on the 20-deg helical angle.

The table is driven through two pinions located 180 deg apart on the centerline that is parallel with the face of the crossrail, by two d-c 50/75-hp motors, balanced electrically to equalize the drive. One back gear is built into the drive mechanism from each motor, thus providing a table speed range of 0.125 to 5 rpm. Back gears are enclosed in boxes attached to each side of the center portion of the bed. The back gear clutches are shifted simultaneously by electric motors operated by means of control buttons. Drive motors and all drive shafts are vertically mounted and run on antifriction bearings.

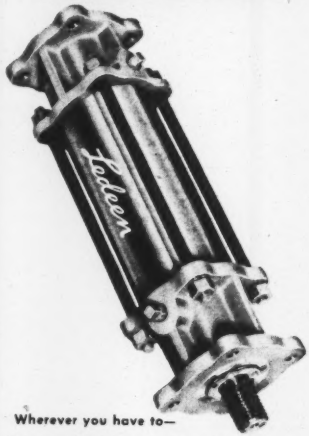
### High-Pressure Reducing Valve

Important improvements are now announced by the Atlas Valve Co., Newark, N.J., concerning No. 197-135 type "E" high pressure reducing valve which handles working pressures as high as 6000 psi.

For a number of years this company has been experimenting with the use of Stellite on valve parts that are subject to severe abrasion and corrison. As a result type "E" is now furnished to users with Stellite-faced main valve and Stellite-faced seat ring. Stellite possesses great hardness, is unusually tough, and is highly resistant to corrosion. It outwears steel many times.

Design changes have also been made in the body of type "E" thereby simplifying and strengthening it. Other internal metal parts are of hard chromium-plated stainless steel. The packings are specially made for the high-pressure service. The pressure on the seat is balanced by a piston above. It handles water, oil, or air—without shock, and with ease.

INCREASE PRODUCTION WITH *Ledeen* CYLINDERS

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PUSH or PULL

LIFT or LOWER

PRESS or SQUEEZE

TILT or TURN

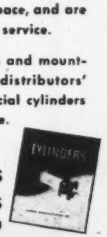
OPEN or CLOSE

**Ledeen cylinders provide positive, dependable power and pressure in straight line motion. Designed for air, oil, or water operation, they are uniform in design and construction, affording a wide number of varieties and adaptations. Ledeen cylinders are easy to install, occupy minimum space, and are built for long, economical service.**

**Standard Ledeen cylinders and mountings are available from distributors' stocks in major cities. Special cylinders if required. J.I.C., of course.**

*Ledeen* Cylinders are GOOD Cylinders

*Write for Bulletin 500*




*Ledeen* Mfg. Co.

1600 San Pedro

Los Angeles 15, Cal.

## • Keep Informed

### Manual Control Valve

A new heavy-duty valve No. 788, manufactured by R-S Products Corp., an S. Morgan Smith Co. subsidiary, Philadelphia 44, Pa., is equipped with totally enclosed gear reduction drive, extended shaft, and floor stand. The sealing of water pressure is obtained by utilizing a babbitted seat in the body and Monel or stainless steel welded to the periphery of the valve disk. Such a metal-to-metal seat gives satisfactory commercial shut-off in most installations. For instance, with a 350-ft head of ambient water, a 36-in. valve with a babbitted seat has a leakage of only 50 gph. Remote, automatic, or semiautomatic controls are also available for this type of valve.

### Overload Indicator

Distribution transformers made by Allis-Chalmers of Milwaukee, Wis., are now available with a new overload indicator operated by a thermostatic element in the top oil. The new device operates purely as a signal warning and does not interrupt the continuity of service to a customer in any way.

The overload indicator thermostatic element is designed to trip 80 C top oil temperature. This corresponds to 50 C maximum top oil rise above a 30 C average ambient temperature. When the oil reaches the predetermined temperature, a signal light snaps on and stays on until turned off by the utility serviceman. This is done by moving the handle indicator in a clockwise direction until the pointer is on the reset mark. The handle is then returned, counter clockwise, to its original "close" position.

### High-Speed Recorder

A new electronic high-speed pen recorder for measuring rapidly changing variables experienced in laboratory and test applications has been developed by Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Philadelphia, Pa.

Full-scale signals which vary as rapidly as 20 cycles a minute can be recorded on the new model, also those with peak-to-peak amplitude of 10 per cent of scale which vary as rapidly as three cycles a second.

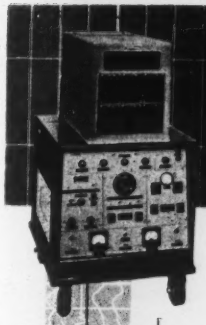
The new device will provide accurate recording in rocket engine testing where thrust of the engine is measured with a strain gage. It will be applicable for analyzing fuel efficiencies and engine designs, and for spectrographic and other analyses where relatively high scanning rates and narrow increments of change are encountered in a measured variable. It is also used for determining instantaneous rates of flow as in jet-engine development.

### Automatic-Focusing TV Tube

Representing a complete departure from the usual TV picture tube design, a new Du Mont Teletron boasts 100% built-in automatic focusing. Eliminating all focusing controls, coils, mechanical focusing devices, this new tube maintains a perfect edge-to-edge focus at all times regardless of line-voltage fluctuations, contrast or brightness settings, or installation procedures.

The Cathode-ray Tube Division of the Allen B. Du Mont Laboratories, Inc., Clifton, N. J., are now manufacturing the new automatic focusing tube in the 17-in. rectangular size, in limited quantities. Other sizes will be announced shortly. The present 17-in. size is a direct replacement for any 17-in. all-glass rectangular picture tube whether electromagnetic, or electrostatic focusing. The base is a standard 5-pin duodecal type, requiring no changes in replacement installations.

*Continued on Page 50*

NEW HIGHS IN RESOLUTION

The Hathaway SC-16A Six Element Recording Cathode-Ray Oscillograph, designed for recording fast transients and continuous phenomena, brings you new highs in resolution because of its unusually high frequency response and high chart speed. Note these unusual features:

FREQUENCY RESPONSE 0 to 200,000 cycles per second • RECORDS up to 1000 ft. long at speeds up to 600 inches per second • RECORDS up to 10 ft. long at speeds up to 6000 inches per second • WRITING SPEED up to 5,000,000 inches / second • SIX ELEMENTS with interchangeablelens stages for 1, 2, 3, or 6 traces on full width of chart • INTERCHANGEABLE RECORD MAGAZINES for continuous recording or short records of fast transients • PRECISION TIMING tuning fork controlled QUICK-CHANGE TRANSMISSION for 16 record speeds • AUTOMATIC INTENSITY CONTROL • CONTINUOUS SWEEP OSCILLATOR.

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*Write for Bulletin 2G1AK*

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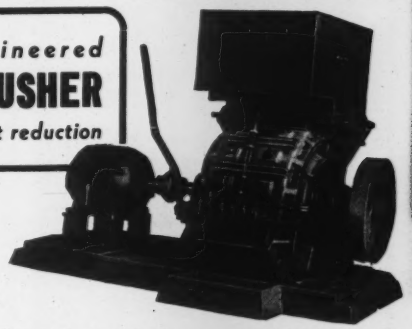
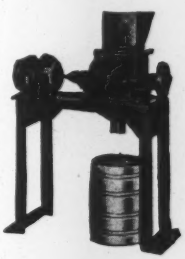
*for uniform . . . low-cost reduction*



. . . of COAL, CLAYS, CHEMICALS, STONE, METAL TURNINGS, WOOD, DRY ICE, FOOD—hundreds of products of every description.



*Laboratory Mill*—for testing, pilot plant operation and waste reduction.

*Metal Turnings Crusher*—reduces long, curly turnings of steel, alloys, brass, aluminum, etc., to uniform chips for highest cutting oil recovery . . . increased scrap value.

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# Opportunity of a Lifetime!

Continued expansion in many of the divisions of Minneapolis-Honeywell—America's leading manufacturer of automatic controls—has created some wonderful new opportunities for graduate electrical and mechanical engineers with research, design or development experience.

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These permanent engineering jobs offer you advantages most men spend a lifetime looking for: an opportunity to use the latest electronic techniques and equipment; a chance to do work bordering on basic research; diversification that affords security, and at the same time allows you to choose the kind of work you like most.

If this sounds like your kind of opportunity, we'd be glad to tell you more about it—and about the fine living conditions and salaries in Minneapolis and Philadelphia. Depending on the location you prefer, write to H. D. Elverum, Personnel Department ME-1, Minneapolis 8, Minn., or W. Reiterman, Personnel Department ME-1, Philadelphia 44, Pa., giving your qualifications and experience. Your correspondence will be held in the strictest confidence, of course.

MINNEAPOLIS **Honeywell**
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## • Keep Informed . . .

### Cosmotron

Westinghouse electric equipment, specially designed to power the 2 billion electron-volt Cosmotron has successfully passed its first tests at the Brookhaven National Laboratory, Upton, N. Y.

This was disclosed with the announcement by the Laboratory that the 2200-ton magnet —key component of the accelerator—has been tested at its full power of 40,000 kw. Other elements are now being added and the complete machine should be ready for trial runs early next year.

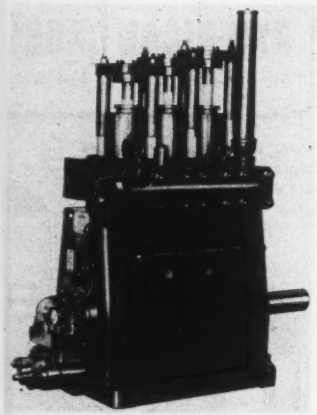
Called the "Cosmotron" because it will give atomic particles energies equal to some cosmic rays, the giant machine is designed to accelerate protons to energies exceeding 2 billion electron-volts, five times greater than those provided by the largest existing cyclotron.

The electric equipment will feed power to the ring-shaped iron magnet, which measures 65 ft in diam and which contains an acceleration chamber for the protons.

The energy is supplied by a large motor-generator set, equipped with a 45-ton flywheel, that delivers alternating current to a battery of 24 ignitron rectifiers. These rectifiers convert the alternating current into 40,000 kw direct-current pulses. Twelve pulses per minute are sent into the Cosmotron magnet to guide the subatomic particles around the acceleration chamber.

### Direct-Flow Triplex Pump

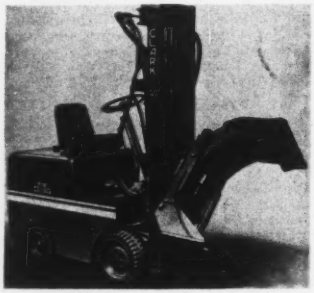
The Aldrich Pump Co., Allentown, Pa., announces the addition of a 3-in-stroke triplex, direct-flow pump to their over-all line. This triplex unit can operate at speeds up to 500 rpm—an increase over previous models, resulting in more work from a lighter, more compact pump. Power ranges up to 50 hp; pressures up to 3800 psi; and displacement up to 96 gpm (3275 bpd) at 790 psi, 500 rpm.



The direct-flow pump was so named because it passes liquid in a straight line, directly through the working barrel. Aldrich engineers eliminated two right-angle turns in the fluid-end block. This change in design resulted in a reduction of "loss space" in the fluid-end. It improved the volumetric efficiency and saved materials as well. The fluid end is sectionalized in construction so that maintenance is simplified and inexpensive. Change in plunger size can be readily made to meet alterations in pressure or capacity.

### Rotating Roll Clamp

A rotating roll clamp designed for attachment to fork trucks of 2000-lb capacity is announced by Clark Equipment Co., Battle Creek, Mich. Heretofore this device has been available only for attachment to trucks of 3000-lb capacity and up. It is designed to handle rolls of not over 1500 lb on "2024" models, and of not over 950 lb on "2015" models.



The unit can be rotated through 90 deg, so that a roll may be picked up from horizontal position and stood on end, or vice versa. It is rotated by a cylinder with chain and sprocket linkage, and is provided with positive stops at vertical and horizontal positions to eliminate excessive strains on the chain.

Clamping action is similar in almost all respects to that employed on larger models. One clamp arm is rigidly mounted and when rotated is always in bottom position for handling horizontal rolls. The second clamp arm is hydraulically actuated and provides a maximum clamping force of 5000 lb. Clamp pads are hinge-mounted to fit against the roll and exert maximum pressure over the entire surface.

### Numbering Tool

A new numbering tool that uses ordinary straight-line flat-surface marking type with an insert segment and thereby becomes a tool for marking convexed surfaces, such as rods, bars, tubes, shafts, etc., is offered by The Acromark Co., Elizabeth, N.J.

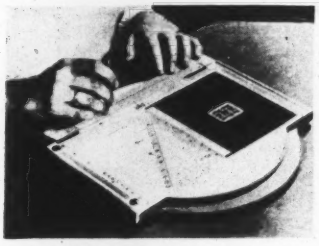
Each piece of type is of standard body width and is easily removed from the holder. However, due to the segment piece blank that is placed between each piece of type, a curvature is obtained conforming to the surface being marked. A formed metal plate with a flange on it, held taut by a coil spring, locks each piece of type and each segment spacer in place firmly, but allows removal and interchanging quickly and simply by thumb pressure on this formed spring pressure clip.

The standard sizes of this new type of concaved holder for marking on convexed surfaces are 4, 6, 8, and 10-piece capacities of type, sizes ranging in 16ths and 32nds from $\frac{1}{16}$ to $\frac{1}{4}$ in. Other sizes can be provided economically on order but are not carried in stock.

### Desk Calculator

A new desk calculator for statisticians in engineering research, industrial quality control, and other sciences, is said to give results faster than an automatic computer or slide rule after only a few minutes of instruction in its use. Made by Graphic Calculator Co., Chicago, Ill., the critical parts of this new computing instrument are made of Vinylite

plastic rigid sheet, produced by Bakelite Co., which has exceptional dimensional stability, is resistant to flame, moisture, and most chemicals, and is easily cleaned with a damp cloth. Statisticians and applied mathematicians in sociology, psychology, engineering, biology, economics, education, opinion analysis, ballistics and many other fields can make complicated statistical analyses to an accuracy of one half per cent or better in a fraction of the time usually required. One simple mechanical operation of the calculator completes as many as five separate mathematical steps in about two seconds. Squares, sums of squares, and square roots, which are commonly required in statistical work, are all performed simultaneously on the calculator. Computing personnel learn quickly and easily to use it in solving for standard deviations, root-mean-squares, correlation coefficients, geometric and harmonic means, regression lines, etc. Based on principles of geometry, the calculator consists of a 10-in. disk which slides and rotates freely beneath a pair of vertical and horizontal scales on which a series of right triangles is graphically formed. Both linear and logarithmic scales are furnished with the calculator. The calculator is approximately 12 in. × 8 in. × 1 in. The complete set also contains a 14-page instruction manual and a needle-steel stylus with an aluminum handle.



### Tri-Clad Vertical Motors

New vertical, solid-shaft capacitor motors featuring standardized mounting dimensions, and quiet operation, have been announced by General Electric's Small and Medium Motor Divisions.

An addition to the company's Tri-Clad intergral-horsepower, single-phase, capacitor motor line, the new motors are available in ratings from ¾ to 5 hp.

Principal application of the vertical motors is on jet pumps and other assemblies for supplying water to homes and farms, and for irrigation. Normally furnished as part of the complete pumps, they are suitable for outdoor operation where severe climatic conditions are not encountered.

### Formbrite

The American Brass Co., New York, N.Y., recently announced the development of "Formbrite" copper alloy sheet, strip, wire, rod, and tube. An unusual combination of physical and fabricating qualities are claimed for the process. Manufacture involves a special procedure of rolling or drawing and annealing brass containing 63 to 90% copper to obtain exceptionally fine grain-size (about 0.008 mm).

Physically the metal is stronger, harder, and "springier" than ordinary drawing brass, yet retains remarkable ductility for deep drawing, forming, and cold upsetting. Its harder surface tends to resist abrasion and scratching. Formbrite can be supplied equivalent to ASTM specifications for either quarter or half-hard stock. The fine grain structure of Formbrite is said to provide metal with a surface so smooth that a simple buffing operation produces a lustrous finish.

Sheet and strip manufactured by this method is offered for practically all drawing brass purposes. Because of its initial high strength and stiffness, cold fabricated parts acquire added strength and stiffness and frequently can be made of thinner metal than if the usual deep drawing brass were used.

In the manufacture of wire products, Formbrite machines and threads with ease and has proved to be ideal for rivets, wood, and machine screws.

### Constant Delivery Pumps

Simplification and compactness are exemplified in three new heavy-duty type "HG" axial rolling piston pumps, announced by Oilgear Co., Milwaukee, Wis. These tried and proved designs have fewer working parts and operate quietly at speeds up to 1800 rpm. Coupled with pressure and flood lubrication by the high-grade oil in the system, they set new standards of service and endurance for pressures up to 3000 and 5000 psi.

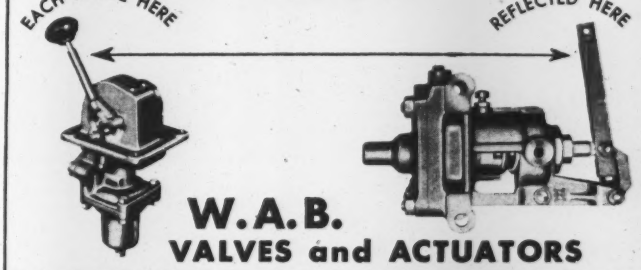
These heavy-duty units are of the fixed-stroke type, the volume of oil delivered varying with the drive shaft speed. Oil is de-

Continued on Page 52


Got any Problems That Call for

THROTTLING
GRADUATING
POSITIONING
} CONTROLS?

Here's your Answer...

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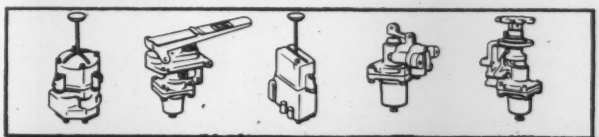
The smallest move of the control-valve handle is "echoed" by proportional movement of the actuator to throttle engines, graduate flow in process operations, positioning actuator to modulate fuel feed to boilers, etc. Eliminates complication and maintenance of mechanical linkage. Only connection is an air tube. Place controls at any distance from operation, centralize command of multiple operations. Hand, foot and cam operated valves available. Ask for Bulletin IDA 9481-1.



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ENGINEERING SOCIETIES YEARBOOK

This book provides information on the purpose, aims, policies, etc. of 318 organizations, including 83 national engineering societies; 174 state, regional and local clubs, councils and societies; 8 international engineering associations; 3 engineering employee organizations; and 5 engineering joint bodies.

Information and addresses of registration boards for licensing professional engineers are given, also a list of the 134 accredited engineering curricula of engineering colleges and institutions approved by the Engineering Council for Professional Development.

*Published 1948* $3.00

*Published by*

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

29 West 39th St. New York 18, N. Y.

## • Keep Informed

livered in one direction. Each compact unit consists of an axial rolling piston pump, a supercharging gear pump, a gear pump relief valve, and an adjustable reverse-flow-type high-pressure relief valve. Over 10 hp is transmitted by units only 7 × 10 × 13 in. About 135 cipm excess gear pump oil at 100 psi is available for auxiliary purposes. Pump, work, and machine are protected against overload.

On a wide variety of applications using repetitive cycles and where controlled variable speed is not essential, Oilgear type "HG" constant delivery pumps will prove most practical and economical. They are especially suitable for heavy-duty pushing, pulling, lifting, and lowering applications, for maintaining high static loads on large clamping rams, and the like.

### Encased Precipitron

You can now buy an Encased Precipitron electronic air cleaner from Westinghouse that resembles a factory-fabricated section of air duct or plenum chamber 96-in. long with a built-in Precipitron. The complete air cleaning package, the Type PE Encased Precipitron, assures minimum installation time and expense with maximum air cleaning efficiency.

The PE units are available in air-cleaning capacities ranging from 8330 cfm at 90 per cent efficiency to 44,000 cfm at 85 per cent efficiency. Efficiencies are measured by U. S. Bureau of Standards Blackness Test Method. A 90 per cent efficiency results when the air velocity is 333 fpm. When the velocity is increased to 400 fpm (up 20 per cent) the efficiency drops to 85 per cent (5.5 per cent).

The over-all cross-sectional dimensions of the PE units range from 5 ft $4^{11}/_{16}$ in. high × 5 ft $2^{1}/_{2}$ in. wide for the 8330 cfm unit to 10 ft $4^{11}/_{16}$ in. high × 11 ft $1^{3}/_{4}$ in. wide for the 44,000 cfm unit. All are 8 ft long. Approximate net weight in pounds is from 1970 for the smallest unit to 4800 for the largest. Add 15 per cent for shipping weight.

For further information about the Type PE Encased Precipitron ask for booklet DB 93-820. Write Westinghouse Electric Corp., Sturtevant Div., 200 Readville St., Hyde Park, Boston 36, Mass.

### Oxygen-Enriched Air Blast

Mixing oxygen with the purifying air blast has enabled steelmakers to beat all past records for their fastest process, the Bessemer converter.

With oxygen a Bessemer "blow" of 30 tons of steel can be completed in nine to ten minutes, one to two minutes less than the normal time. Translated into practical terms, this means a bonus of 30 tons every 12 to 15 blows, or 60 tons for each Bessemer converter in an eight-hour day.

Still more important from the steelmaker's standpoint, the use of oxygen makes it possible to charge at least five tons of scrap into the converter, two tons more than in normal practice. This means a saving of pig iron, usually the fare of the fire-breathing Bessemer vessel, and consequently a reduction in the amounts of iron ore, limestone, and coke required by the blast furnace to supply the Bessemer shops.

Experiments leading to this achievement were performed at National Works of National Tube Company, a United States Steel subsidiary, in McKeesport, Pa. Steel so made is used to manufacture pipe and tubing or is charged into open-hearth furnaces for further processing. In testing this method over a four-month period, no change was noted in the quality of a converter lining shortened.

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**Patented Flexible Disc Rings of special steel transmit the power and provide for misalignment and end float.**

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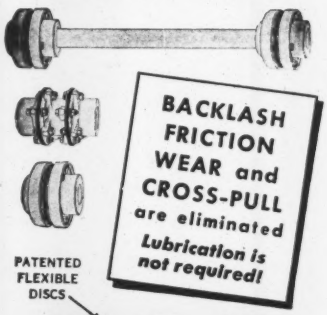


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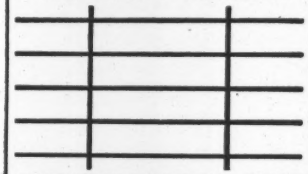

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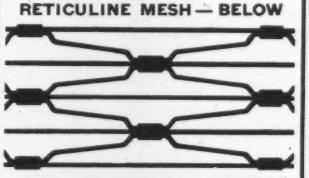
or
RETICULINE MESH — BELOW



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## • Keep Informed

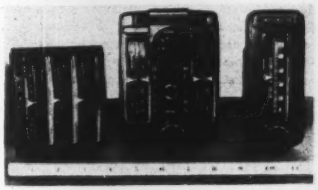
It was found that slightly more than one per cent of oxygen added to the normal air of the blast was not only sufficient but operated with the best results. This amounts to 4000 to 6000 cu ft of oxygen for each "blow." The most efficient rate of oxygen addition was found to be 1000 cfm, and the most effective time for its introduction was during the first four minutes of that portion of the blow designed to remove carbon from the charge. This permits two or three minutes of end blowing without oxygen to avoid excessive over-oxidation of the metal and slag.

Close to 3000 oxygenated blows were tried in the National Tube research experiments.

The main purpose of the experiments was to melt as much additional scrap as possible in the Bessemer converters during a hot-metal shortage while a blast furnace was being rebuilt.

### Miniature Controls

Lower operating expense and reduced space requirements for control panels in power and industrial process plants can now be had as a result of the development by Bailey Meter Co., Cleveland, Ohio, of new miniature indicators and control units. These instruments offered under the trade name "Mini-Line" make it practical to concentrate into a small space before a single operator all information and controls for operating one or more boilers, turbines, or process units such as cement mills, foundries, fuming plants, pulp and paper mills, chemical plants, and refineries.



It is planned to mount "Mini-Line" instruments on console-type centralized-control panels whenever possible. These panels will be more than 50% smaller than any previously available. Control from a centralized "Mini-Line" control panel may be entirely automatic, or if the operator wishes, individual units or the entire system may be controlled manually from relays.

Space savings are considerable. A new multipoint indicator uses 87% less space than its standard size counterpart. A selector valve uses 52% less space, and a remote manual relay uses 70% less space. The accompanying photo shows, from left to right, the multipoint indicator, selector valve, and remote manual relay.

### Cobalt-Platinum Magnet

A cobalt-platinum magnet, which in small sizes is described as the world's most powerful permanent magnet, has been developed by scientists of the General Electric Research Laboratory, Schenectady, N.Y.

Present commercial use of the new magnet will be limited, however, not only by government restrictions on the use of cobalt, but by prohibitive expense of the large amounts of platinum used in the alloy, the scientists said.

They do not foresee the new magnet replacing presently used magnetic alloys, such as the Carboloy Alnico magnets, but rather believe that new fields of use will be opened, for which existing magnets are not suitable.

Compared with Alnico-5 magnets, gener-

*Continued on Page 54*

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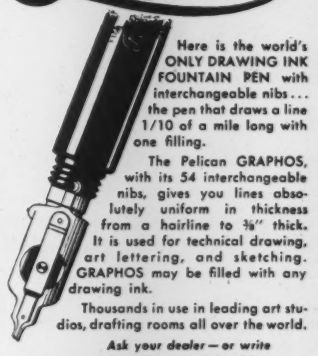

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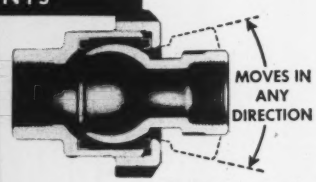
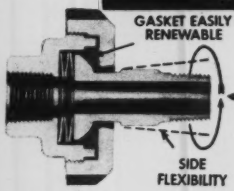
*"One joint does the work of two or more!"*—because it moves in any direction. Standard the world over where low cost, leakproof movable joints are needed in piping handling steam, air, water, oil, gas, or chemicals. Many models available. Up to 40° side flexibility *plus* 360° swivel action. Also used to facilitate quick connection of piping, overcome misalignment. Pressures to 6,000 psi; temperatures to 1,000° F. 15 different sizes, ¼" to 12". *Bulletin 215.*

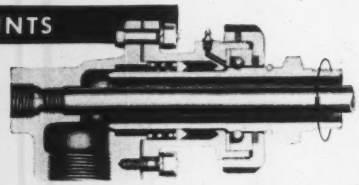



## ROTARY SWIVEL JOINTS




Exclusive angular motion prevents binding—only Barco offers this important advantage! Widely used for making compact, low torque swivel connections to reciprocating or rotating parts on platen presses, tire molds, oil burners. Easy to position piping accurately—no sagging, flopping lines. Leakproof, safe—pressure or vacuum. Ratings as high as 600°F., 3,000 psi (hydraulic). Sizes, ⅜" to 2"; angle or straight. *Bulletin 265.*

## REVOLVING JOINTS



Minimum roll "drag" cuts power costs—up to 50% savings! Note wide spacing between bearings; inherent low torque little affected by pressure, speed, or temperature. Parts easily accessible. Light running action minimizes wear, permits free-floating installation. No adjusting necessary—long, leakproof service. Ratings to 250 psi (steam); 450°F. Single flow or syphon styles. Sizes ½" to 3". Wide choice of models; speeds to as high as 2,500 RPM. *Bulletin 300.*

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## • Keep Informed

ally rated as the most powerful in commercial use, the new magnet is less powerful in large sizes but more powerful in small sizes, according to the scientists.

Laboratory experiments with a new magnet about the size of an eraser on a lead pencil, and a similar sized Alnico-5 magnet, show the new magnet to have lifting power 24 times greater than that of Alnico-5, and about eight times more resistance to demagnetization.

They said that this resistance to demagnetization, called coercive force, enables the cobalt-platinum magnet to be more efficient in smaller sizes than any permanent magnet now in commercial use.

Other advantages of the new magnet are its ductility, or ability to be drawn into wire or thin sheets, and its comparative ease of machining. Alnico magnets can be machined only with great difficulty, the scientists said.

### Strain Gage Pressure Measurements

Pressure measurement and control of the whole Plantation Pipe Line system will be effected through resistance wire strain gage pressure cells, it is announced by Baldwin-Lima-Hamilton Corp., Philadelphia, Pa.

The new installation is being applied to both existing and new 18-in. and 14-in. lines being built between Baton Rouge, La., and Charlotte, N.C., at a cost of $51,700,000.

Unlike conventional Bourdon gages, Baldwin SR-4 pressure cells do not require frequent calibration by special technicians and do not require product lines to the control panel. They measure pressure directly in the line, are unaffected by pressure pulsation from the pumps, and give higher accuracy. Pressure variations are transmitted to the instrument panel by 4–8 volt lines carrying less than 0.1 amp electric current and using less than one watt of energy.

### Periodic Reverse-Current Plating

A revolutionary, yet simple, method of metal plating developed by Westinghouse Electric Corp., Pittsburgh, Pa., in 1948 may conserve critical nickel and still provide the nation's new automobiles and appliances with bright, corrosion-resistant trim.

The technique—called periodic reverse-current plating (PR plating)—can be applied easily to auto bumpers, door handles, radiator grilles, body trim, toasters, irons, and tubular furniture.

Where no nickel at all is permitted, such as on appliances and auto trim the new process is said to provide a chrome-on-copper finish that is as bright as the standard finish and has satisfactory corrosion resistance.

In other cases where some nickel is permitted—auto bumpers, for example—PR plating makes it possible to substitute copper for a major part of the nickel normally used, thus achieving a big savings of this critical material.

In using the Westinghouse system, a layer of copper—about 0.001 in. thick—is plated onto the steel base. If nickel is allowed, a layer about one-half the thickness of the copper layer is added. The coating is completed with a film of chrome that may be less than $^{1}/_{100,000}$ in. thick. Before nickel was put on the critical list, the conventional method was to plate the steel first with nickel and then chrome.

Although not as scarce as nickel, copper is also a critical material, Westinghouse points out. But the new plating system requires only small quantities—much less than for other metal substitutes proposed. In addition, many hundreds of thousands of gallons of copper-plating solution already are available for use.

## • Keep Informed

The key feature of the new plating system, is the periodic reversal of short duration of the plating current. This alternately deposits metal on the surface to be plated, then during the reversal, takes some of it away. Continuation of this cycle builds up a plate quality superior to anything previously obtained from straight, unreversed direct current. In effect, the PR system makes it possible both to improve surface smoothness and brightness, and to enhance the body quality of the deposit.

### Air-Fuel Ratio Controller

An air-fuel ratio controller announced by Leeds & Northrup Co., Philadelphia, Pa., adjusts air flow to fuel flow changes rapidly, yet without cycling. Applicable to oil or gas firing, or to dual-fuel furnaces, it meters both fuel and air flow for maximum accuracy of control. Available for use where ratio control alone is desired, this instrument is a component of L&N integrated control of temperature, draft, and combustion of large fuel-fired furnaces and kilns. Models are supplied to operate an electric or a pneumatic control valve.

Added speed and sensitivity are obtained with full stability through the use of an improved control circuit identical with that incorporated in the latest L&N temperature control systems. Wide range of proportional band and reset control actions makes it easy to adjust the control to the needs of the furnace to which it is applied.

The controller comes in a single instrument case which fits into standard panel cutouts. Ratio range extends from 50% deficiency to 100% excess air. Direct remote control of air flow, and transfer from manual to automatic control are provided on the front of the instrument.

### Diesel-Powered Lift Truck

A new industrial fork lift truck, powered by a Diesel engine and equipped with a hydraulic transmission was announced by Philadelphia Division, Yale & Towne Mfg. Co. Called the "Diesel-Lift," this new truck is specifically designed for applications where fire hazards exist, where there is a limited amount of fresh air, and in outdoor areas where continuous heavy-duty operation is a necessity.

This is the first unit of this type commercially available in the United States.

Designed principally for outdoor use, the new Yale truck utilizes a Hercules six-cylinder Diesel engine with a continuous rating of 70 hp. It's equipped with standard Bosh governor controls.

All power impulses from the engine are transmitted through a double-impeller fluid coupling. There is no unyielding metal-to-metal driving connection. This fluid coupling due to its hydraulic balance, eliminates chattering, stalling and stumbling, damaging starts and stops, and assures the availability of full engine power for heavy pulling and steep ramp work.

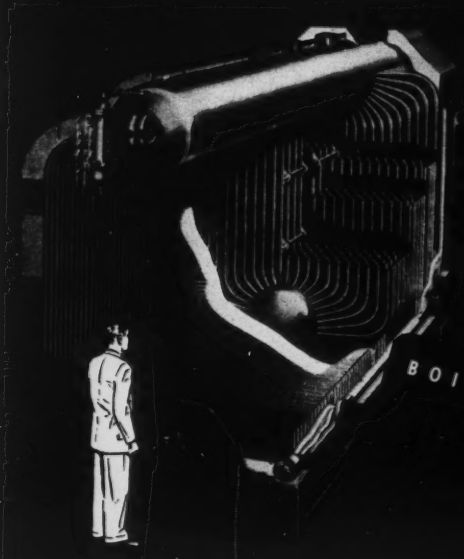
### Oscillating Trough Conveyer

Link-Belt Co., Chicago, Ill., announces that it has developed and is now in production on a new conveyer of oscillating trough type, called Link-Belt Flexmount, for the handling of a great variety of loose bulk materials at moderate capacities.

The company states that the conveyer construction is ideal for handling foodstuffs, chemicals, and other material where cleanliness, contamination, or corrosion is a factor, and that very hot, sharp, jagged, or oily material, such as steel chips and turnings, are

*Continued on Page 58*


*For easier installation — Lower maintenance*




TYPE B DESIGN FEATURES

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*This Type B — Boiler By Bigelow being installed was shipped completely assembled. It has a capacity of 20,000 lbs. steam per hr. continuous, 25,000 lbs. steam per hr. peak loads. The boiler is 10'7" wide, 21'9" long, 15'10" high and has 3,287 square feet of heating surface.*

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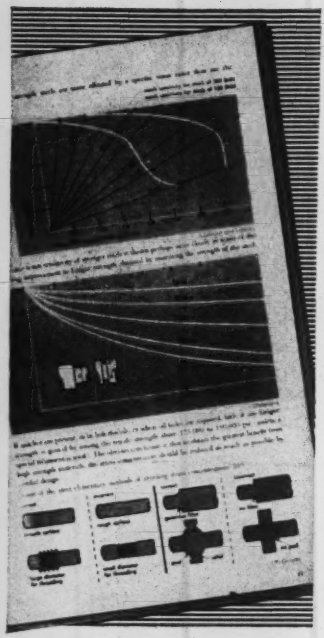

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handled with virtually no wear of metal troughing. Escape of dust or gases can be eliminated by the addition of a metal cover with flexible connections at loading and discharge points.

The Flexmount design features the use of a one-piece metal trough with high sides, supported on simple one-piece flexible members which function as springs in absorbing the energy of the trough movement at each end of the stroke.

Conveyer trough is normally 4 in. deep and can be furnished in standard widths of 8 to 24 in., made of No. 10 or 12 gage steel, stainless or corrosion-resisting steel, or other special material. Motion is imparted to trough by a roller-bearing, constant-stroke eccentric.

Uniform, continuous flow of material is assured regardless of overloads or surges. The handling action, it is stated, is so gentle and easy that there is no degradation of thin or brittle material.

The trough oscillates at the natural frequency of the Flexmounts, reducing the reaction forces on the drive to a minimum and requiring only the horsepower necessary to convey the material.

The Flexmount is very compact and requires an opening only slightly larger than the trough. Troughs in lengths up to 100 ft can be furnished, and dividers can be installed to convey several materials simultaneously. Discharge is possible at any desired point.

### Aluminum Marine and Barge Hose

Developments in the design of all-metal loading and unloading lines, including the use of aluminum tubing and aluminum swivel joints, now provide advantages which are not obtainable with rubber or synthetic hose. These advantages are clearly demonstrated by the aluminum marine and barge hose made by Chiksan Co., Brea, Calif., now being used on a number of different dock installations.

One primary advantage derived from the use of aluminum is the substantial saving in weight which makes the hose easy to handle. Another is the fact that this hose is not affected by severe temperature and climatic conditions which affect the physical properties of rubber and fabric and shorten the length of life of that type of hose. Still another is that the aluminum hose will handle many types and kinds of products which are injurious to rubber or rubber-base compounds.

The Chiksan aluminum marine and barge hose is engineered for easy handling and for quick dock-to-vessel connections. Operating experience shows that connections can be made by one man in less than 10 min. When not in service, the hose is swung back to the mast without requiring disconnection from the dock riser. This saves time and labor as well as dock space and permits free movement of other equipment without danger of damage to the hose. In addition, the all-metal construction provides greater resistance to wear and to accidents or sabotage. This hose is not subject to kinking, crushing, or cutting.

### Translucent Drawing Reproduction Paper

Kodagraph Autopositive Paper, Translucent, a tough, durable, and highly translucent new drawing reproduction paper is now being distributed by the Eastman Kodak Co., Rochester, N.Y.

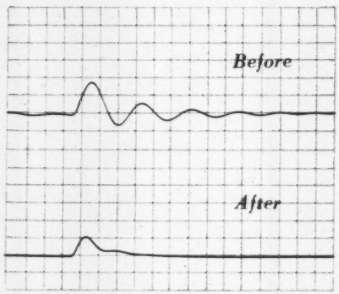
Designed to meet exacting requirements in the drawing copy field, the new paper is coated with the same emulsion used on "regular" Kodagraph Autopositive Paper.

The paper on which the emulsion is coated,


# Engrg.

and Research Programs may be greatly *abbreviated* by a Philbrick Analog Computor of the high-speed all-electronic variety.

Dollars and days in surprising numbers have been saved by enterprising engrs. who have recognised the applicability of these little machines to their development probs.




How do we stabilize this structure or system? What is the optimum combination of these parameters? Why cannot this process be accelerated without sacrifice in efficiency? —

Questions of this sort and many others are answered regularly by analog systems assembled directly and conveniently from GAP/R Computor Components.

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## • Keep Informed

however, is considerably tougher. It will withstand longer and rougher handling without tearing. This assures greater life on the drafting board and in the reproduction department.

Another feature is the ease with which drawing changes can be effected. Lines erase readily when moistened.

The new paper, like regular Kodagraph Autopositive Paper, can be handled on familiar reproduction equipment and in ordinary room light. It results in black-line prints from original drawings. The quality of these prints often represents an improvement over the originals.

As a result of its greater translucence, blueprints and direct process prints can be turned out up to 30% faster. Furthermore, details printed on Kodagraph Autopositive Paper, Translucent, can easily be read through the back of the sheet. As a result, reverse-reading Autopositive, Translucent intermediates are easy to work on.

### New Finishing Sander

Cost-conscious builders, carpenters, auto body workers, and home and boat owners will find the new Porter-Cable Guild orbital motion sander the answer to many finishing problems. The new sander, made by Porter-Cable Machine Co., Syracuse, N. Y., and designated the Model 105 Finishing Sander, is not a "vibrator" sander, but a powerful motor-driven machine with two counterbalanced transmissions.

Smoothing wallboard joints, finishing cabinets and doors, and prepainting preparation are only a few of the building tasks which this new sander handles quickly and efficiently. Home-owners will find the machine useful for many other purposes.

In addition to its many woodworking applications, the Guild Sander has industrial applications in sanding metal and enameled metal surfaces. In auto body shops, it successfully handles such jobs as preparing base surfaces, feather-edging, leveling solder joints, and smoothing primer.

The abrasive pad of this machine revolves a $^3/_{16}$-in-diam orbit at 5000 rpm. Consequently the thousands of abrasive grits traveling in tiny, overlapping circles produce a uniform, smoothing action on wood, metal, plastic, and composition. The result is a "hand-rubbed" finish without scratch or mar regardless of the direction in which the sander is guided.

This compact sander, 9 in. long, 3 in. wide and $3^3/_4$ in. high, is easily maneuverable in corners and close to trim or molding. Its lightweight, 5 lb, makes it an ideal tool for overhead or vertical sanding. Another fatigue-reducing factor is the smooth, vibrationless operation of the motor.

### Ore Unloaders

Two giant electrically powered ore unloaders, each capable of unloading ore boats at the rate of 21 tons a min, have been recently installed by the Baltimore and Ohio Railroad Co. at its Curtis Bay Import Ore Dock at Baltimore, Md.

The complete pier installation, a $5,000,000 facility to handle import ore, is powered by direct current provided by two new pumpless ignitron rectifiers rated 1000 kw each.

Developed by the General Electric Co., the two rectifier units are the first of their type ever used to power ore-unloading equipment.

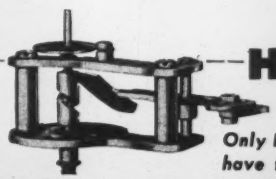
The units, according to G-E engineers, will deliver rated current of 4000 amp at 250 volts for two unloading towers, two new G-E pusher locomotives, and one loading hopper with its associated conveyers and gates.

These rectifiers are permanently evacuated

*Continued on Page 58*

• At one time the French Chamber of Deputies was debating women's suffrage. When one liberal soul pointed out that there was very little difference, after all, between the sexes, a fellow deputy leapt to his feet and shouted with gusto, *"Vive la difference!"*

Two pressure gages may seem alike. But the difference between a HELICOID and any ordinary gage is unique. So much so that otherwise complacent engineers, who usually keep their feet on the ground, have been known to jump with ecstasy and exclaim, *"Vive la difference!"*



HELICOID

*Only Helicoid Pressure Gages have the Helicoid Movement*

ACCO

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE COMPANY, INC.
Bridgeport 2, Connecticut

TRADE MARK

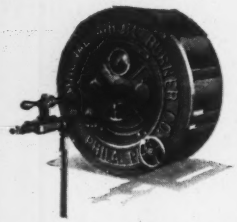
# REGISTER TYPE COMBUSTION UNITS . . .

## FOR YOUR "CONICAL FLAME" REQUIREMENTS

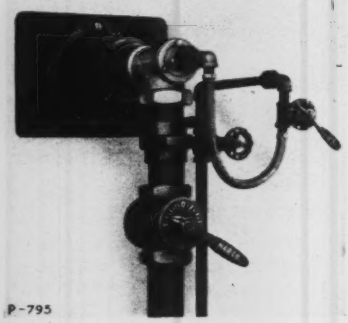
**UNIVERSAL (REGISTER TYPE) COMBUSTION UNIT**

Can be furnished with Gas Burners or steam or mechanical atomizing Oil Burners, for either natural or forced draft. Air vanes are variable independently of each other and adjustable or instantly reversible from left to right hand turbulence or vice versa as a unit. Has a dual feature for controlling air volume, independent of turbulence. Capacities up to 500 gals. of oil (60,000 lbs. steam) per hour.

**MECHANICAL-PRESSURE ATOMIZING OIL BURNERS**



Mechanical-pressure atomizing (marine type) oil burners for firing high pressure steam boilers. Capacities 10 to 500 gals. per hour. Require oil pressures of 75 to 300 lbs. per sq. in. and oil temperatures up to 300° F., depending on grade of fuel oil and furnace design. Standard or wide range types. Air Registers available for natural or forced draft.



P-795

**LOW AIR PRESSURE OIL BURNERS**

Type LAP Burner and Register, shown mounted on furnace wall with Indicating Air and Oil Control Valves. The Type LAP Oil Burner is for use with low pressure air for firing forging, reheating, heat treating furnaces, crucibles and other metal melting furnaces, core ovens, galvanizing kettles, dryers, bake ovens, cookers, air heaters, kilns, glass tanks, glory holes, enameling furnaces, asphalt kettles and other process furnaces. (Patented July, 1943.)

Where it is preferable to use the cone flame for firing steam boilers and other industrial furnaces, NATIONAL AIROIL BURNER CO. offers these Register Type Combustion Units in several types, and models for either natural or forced draft.

NATIONAL AIROIL BURNER CO. stands ready to serve your every need or special problem when it comes to Oil Burners—Gas Burners and allied equipment. We feel that you'll be interested in the full particulars we give regarding your oil-gas-combustion requirements . . . write us today, won't you?

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes; STEAM ATOMIZING OIL BURNERS; MOTOR-DRIVEN ROTARY OIL BURNERS; MECHANICAL PRESSURE ATOMIZING OIL BURNERS; LOW AIR PRESSURE OIL BURNERS; GAS BURNERS; COMBINATION GAS and OIL BURNERS; AUTOMATIC OIL BURNERS, for small process furnaces and heating plants; FUEL OIL HEATERS; FUEL OIL PUMPING and HEATING UNITS; FURNACE RELIEF DOORS; AIR INTAKE DOORS; OBSERVATION PORTS; SPECIAL REFRACTORY SHAPES.

**NATIONAL AIROIL BURNER CO., INC.**

*Main Office & Factory:* 1239 EAST SEDGLEY AVENUE
PHILADELPHIA 34, PA.
SOUTHWESTERN DIVISION: 2512 SOUTH BOULEVARD
HOUSTON 6, TEXAS


## • Keep Informed

at the factory, eliminating the extensive vacuum pumping equipment previously associated with large electronic rectifiers.

Besides powering the unloading towers, conveying equipment, and hoppers, the rectifiers will supply power for operating the narrow gage, side-arm pusher locomotives which are used under the hoppers to rapidly spot cars.

These pusher locomotives, built by G-E, are able to move cars on either of two loading tracks to receive ore from the weighing hopper and to speed the make-up of the ore trains.

## • BUSINESS CHANGES

### Reading Chain & Block Corp. Changes Name

The Reading Chain & Block Corp., Reading, Pa., has changed its name to Reading Crane & Hoist Corp., effective June 1, 1951. The change of name does not affect the capital structure, personnel ownership, or production of the company, but is merely more descriptive of the company's operation. Management will continue to be under Fred A. Howard, president; Philip K. Howard, vice-president; and Frank M. Howard, secretary-treasurer.

Up to 1918, principal products of the company were chain and chain blocks, but since that time, their production has been chiefly cranes and electric hoists.

### Chiksan Announces New Appointments

New appointments by Chiksan Co., Brea, Calif., include the following:

N. A. (Lee) Guill, division manager of Chiksan's Chicago branch office and sales supervisor of the Chicago district, with offices at 122 South Michigan Ave., Chicago.

W. L. Clark has been appointed Chiksan sales representative in the Chicago territory and assistant to Lee Guill.

G. W. Beecroft & Co., 15 St. Mary St., Toronto, Ontario, Canada, Chiksan sales representatives for the Province of Ontario.

Sociedade Commercial de Materias Primas Ltda., Rua de Alfandega 41-S, 609/17, Rio de Janeiro, Brazil, are now Chiksan representatives in this country.

### Westinghouse Opens New Chicago Offices

A 46,000-sq ft office, bathed in artificial sunlight the year-around, was publicly opened recently in Chicago, Ill., by the Westinghouse Electric Corp.

Considered an advanced step in office design, the new Westinghouse Northwestern District headquarters located in Chicago's giant Merchandise Mart features: (1) fluorescent sunlamps irradiating the entire office area; (2) germ-killing Sterilamps installed in the ventilating system; (3) bright colors on walls to provide cheerful surroundings; (4) acoustical soundproofing, modern fluorescent lighting, and complete air conditioning.

### Du Mont Appoints Regional Sales Manager

The appointment of Frederick W. Timmons, Jr., as regional sales manager for the Cathode-ray Tube Division, Allen B. Du Mont Laboratories, Inc., is announced by Bill C. Scales, national sales manager. Mr. Timmons is already at work in his new post.

Mr. Timmons will make his headquarters at the Du Mont Cathode-ray Tube Plant at Allwood, N. J.

## • Keep Informed

### S.S.White Appoints Western District Manager

I. F. Thomas has been appointed manager of the newly established Western District office of the S.S. White Industrial Division. He will be located in the Times Building, Long Beach, Calif.

Mr. Thomas will handle all activities in connection with S.S. White flexible shafts, resistors, valves for compressed gases, plastic products, and aircraft accessories in the Northwestern, Southwestern, and Far Western States.

### Allis-Chalmers Names Two New Midwest Sales Representatives

Robert E. Ketten and William C. Hall are newly named sales representatives to Allis-Chalmers general machinery division district offices in the Midwest.

Mr. Ketten has been transferred from the company's water-conditioning section to the Milwaukee district office where he succeeds H. E. Eigner as water-conditioning sales representative. Mr Eigner has been called into military service.

### Kellogg Names New Officer to Head Sales

Russell J. Wolf, formerly assistant to the president of M. W. Kellogg Co., New York, N. Y., has been named vice-president in charge of sales for the company. In this capacity, Mr. Wolf will be responsible for Kellogg's multimillion dollar sales volume. He will also continue to supervise Canadian projects as a vice-president of Canadian Kellogg Company, Ltd.

### Westinghouse Expanding Sharon Transformer Plant Property

The Westinghouse Electric Corporation's Transformer Division at Sharon, Pa., is purchasing 6¾ acres of land immediately adjoining the present plant area, according to a recent announcement.

Although the ultimate use of this land was not disclosed, Mr. Snyder indicated that Westinghouse is "looking forward to expansion of its facilities in the Shenango Valley."

### Worthington Moves Sales and Engineering Functions

Sales and engineering functions of the Water Treating Section of Worthington Pump and Machinery Corp. has been moved from the company's Dunellen, N. J., plant to its Harrison, N. J., plant.

The engineering function for the Water Treating Section will continue under the charge of J. F. Sebald and the sales function under A. L. Jones.

### Canadian Westinghouse Supply Company Formed

Formation of a wholly owned subsidiary, the Canadian Westinghouse Supply Co., to distribute products of the Canadian Westinghouse Company, Ltd., has been announced.

The new company will establish facilities in principal trading centers throughout Canada that will enable customers to buy complete lines of electrical equipment and home appliances.

In addition to Westinghouse merchandise, the Supply Company will sell under contract other lines such as cable, conduit, and fittings not manufactured by Canadian Westinghouse. In this way, builders, contractors, and small and medium industry will be able to purchase complete lines at one location.

*Continued on Page 68*


# Cylinder Life Increased 25-30%

because OILGEAR uses the PROFILOMETER

In the production of hydraulic pump cylinders at the Oilgear Company, Milwaukee, Wisconsin, the Profilometer is used in two ways. First, it is used when all pilot models of cylinders are being constructed to help determine the optimum surface finish required for maximum life and efficiency of the part. Then, as a production tool, the Profilometer insures that each part will conform to the specifications that are set up. Oilgear engineers estimate that use of the Profilometer in this manner, as compared to previous methods of surface inspection, *has increased the life of the cylinders 25-30%.*

In its use as a shop tool at Oilgear, the Profilometer has a continuous function in the production of the cylinders. It checks both the finish grind and the final lapping operation which must produce a rating of 50 microinches or less. In addition, pistons for all cylinders are held to about a 6 microinch finish, and these, too, are checked in production with the Profilometer

Fast, accurate surface measurement is important to Oilgear's operations. The Profilometer gives it to them.

*To learn how the Profilometer can help cut costs in your production, write today for these free bulletins.*

*Profilometer* is a registered trade name.

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*Instrument Manufacturers*
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...requiring high-temperature controlled-pressure atmospheres

With more than 30 years of successful experience in designing combustion systems for pressure and other types of firing, Peabody delivers better-than-specified performance on all Direct Fired Air Heater installations.

Compact, flexible and custom-engineered to the job, Peabody Air Heaters can be used throughout industry on such typical installations as:

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580 FIFTH AVENUE • NEW YORK 19, N.Y.
Manufacturers of all types of combustion equipment, direct-fired air heaters, gas scrubbers, coolers, and absorbers

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*Write for Bulletin 600-D*


## • Keep Informed

### G-E to Operate Vermont Plant

As part of its expansion program for jet-engine production, the General Electric Co. announced that it will begin manufacturing operations in Ludlow, Vt.

The announcement was made in connection with the signing of a five-year lease with Ludlow Industries, Inc., for a three-story factory building containing approximately 50,000 sq ft of manufacturing space.

The new plant will be devoted to the manufacture of drop forge dies. The dies will be used primarily for the J-47 jet engine program although others for motor and street-lighting manufacture at the company's Lynn, Mass., River Works also will be turned out there.

### Metallurgical Laboratory

To improve its products and to assist customers confronted with unusual problems, National Tube Co. has established a new laboratory at 327 Craft Ave. in Pittsburgh, Pa. Consisting of three stories and a basement, this United States Steel subsidiary's laboratory is provided with the most modern equipment for testing materials and for conducting extensive research into metallurgical problems.

An entire floor, the third, is devoted to electronic measuring devices, a photoelastic stress analysis laboratory, microscopes, oscillographs, and an engineering drafting department. A magnetic detector of soft spots in pipes has been developed here to replace spark testing in some applications. The detector consists of a boxlike device that fits over the pipe to be tested. It is basically a transformer with the pipe functioning as the core. As the physical properties of the core vary, so do the voltage and output of the transformer. Sensitive gages, measuring these variations, give an accurate picture of the pipe's characteristics. This test, besides its speed and accuracy, has the advantage of being nondestructive to the material under observation.

For analyzing three-dimensional stresses that occur in pipe joints and threaded unions, a modern photoelastic stress analysis laboratory is available.

For measuring impact stresses and other stresses of short duration, the laboratory is equipped with a cathode-ray oscillograph capable of photographing tests at rates varying from 1 in. of film a min to 60 in. a sec.

Metal structures are studied in a standard metallurgical microscope with 2500 diam maximum magnification. Auxiliary equipment for mounting samples consists of a cut-off wheel, mounting press, wet grinders, and wheel polishers. There are two darkrooms for developing prints and negatives.

On the second floor are the offices as well as the conference room and research library, an extensive creep-test laboratory, and equipment for hardness and other testing of steel products.

Standard equipment is available for conducting Vickers, Brinell, and Rockwell hardness tests. On this floor also is complete equipment for creep and creep-rupture tests.

The largest installation on the first floor is the modern and fully equipped machine shop, where parts for maintenance and repair of the many testing facilities in the laboratory are fabricated. The machine shop also cuts, turns, and polishes steel samples in necessary sizes and shapes for each of the various hardness, tensile, creep, fatigue, and other tests.

There is a complete chemistry laboratory on this floor and two rooms have been set aside for facilities to test lubricants, not only for National Tube Company, but for other subsidiaries of U. S. Steel, as well.

## • Keep Informed

### Six G-E Manufacturing Affiliates Become Departments

Six manufacturing affiliates of the General Electric Co. became departments of the parent company on June 30, it was recently announced.

The affiliates are Carboloy Co., Inc., with headquarters in Detroit; General Electric X-Ray Corp., Milwaukee; Locke Inc., Baltimore; Telechron Inc., Ashland, Mass.; Monowatt Inc., Providence, R. I.; and The Trumbull Electric Mfg. Co., Plainville, Conn.

In a letter to the company's more than 250,000 stockholders, it was pointed out that the six affiliates will become G-E departments as "a part of the natural evolution of the company's organization through the years."

These six subsidiaries enjoy a strong acceptance of their products and trade names in their respective industries. As departments of the General Electric Company, they will continue to operate under their present management and their products will continue to be marketed under their existing trade names.

### American Chain and Cable Appoints Sales Manager

Vincent Lysaght has been appointed sales manager of the Helicoid Gage Division of American Chain & Cable Co., Inc., Bridgeport, Conn.

Mr. Lysaght has directed the sales of the Campbell Machine Divison and Wilson Mechanical Instrument Division (Rockwell Hardness Testers) in the past, and in assuming his new duties brings an intimate knowledge of the technical requirements of industry.

### Heli-Coil Moves To New Plant

The Heli-Coil Corp., announces that the production of Heli-Coil thread inserts—for the protection and repair of tapped threads—is under way with a skeleton crew in the company's new plant at Danbury, Conn.

All of its machinery, equipment, and key personnel have been moved from its present plant in Long Island City, N. Y.

In addition to the manufacturing area, laid out to take advantage of straight-line production methods, the new one-story brick, concrete-block and steel structure will also house the firm's executive, administrative, and sales offices and its engineering and product-development departments. Ten acres of land are provided for future plant expansion.

### Rockwell Expands Southward

A new plant is being built at Tupelo, Miss., for Rockwell Mfg. Co. Construction was started in March and is scheduled for completion by this fall. It is a one-story building and covers 150,000 sq ft. Rockwell with headquarters in Pittsburgh, Pa., builds a wide variety of products including valves, gas meters and regulators, water meters, taxi meters, fare registers, cash registers, and power tools.

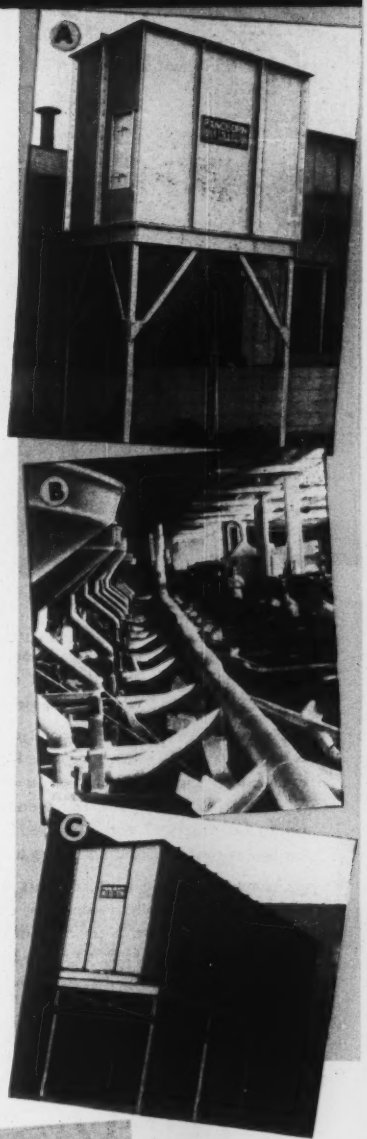
### Leeds & Northrup Moves Boston Office

The Boston office of Leeds & Northrup Co., Philadelphia manufacturers of electrical measuring instruments, automatic controls, and heat-treating furnaces, has moved to 430 Lexington Ave., Auburndale (Boston 66). This new, larger office affords better facilities for providing engineering information and service to manufacturers, researchers, and educational institutions in the Boston area.

*Continued on Page 82*


Pangborn DUST CONTROL

Turns Dust Into Profits!



**A** **At Flury Foundry,** this small and inexpensive Pangborn Dust Collector stops dust caused by blast cleaning operations . . . pays its own way in increased efficiency.

**B** **At Dodge Cork Company,** a Pangborn Dust Control System salvages $5000.00 worth of cork dust every year from some 40 sawing and polishing machines.

**C** **At Landers, Frary & Clark,** a Pangborn Dust Collector like this traps 522 cu. ft. of cast iron dust per day . . . company records prove maintenance costs are lower than ever before.

Dust is no problem for plants with Pangborn Dust Control. As these three cases (picked from hundreds in our files) show, a Pangborn Dust Control System *saves money* on maintenance when dust is a nuisance, saves money when dust has salvage value.

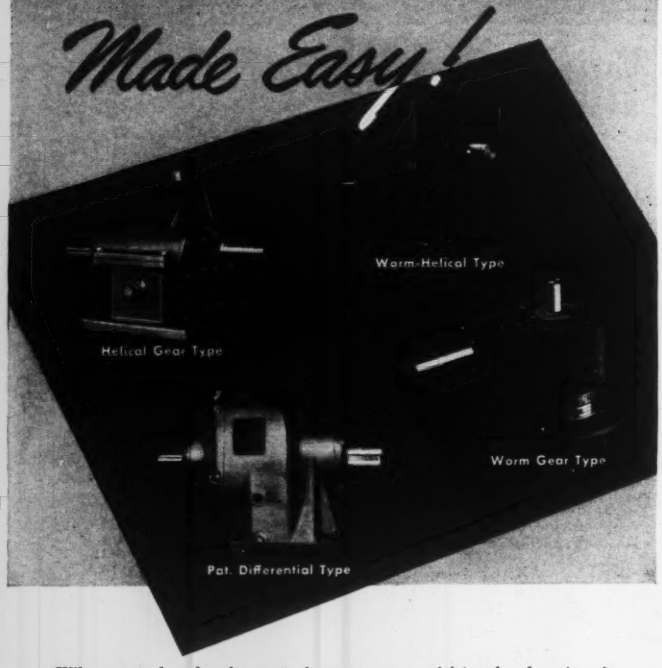
***FIND OUT TODAY*** how you can *save money* with Pangborn Dust Control. Write for your copy of Bulletin 909-A to: PANGBORN CORPORATION, 2200 Pangborn Blvd., Hagerstown, Md.

Look to Pangborn for the latest developments in Dust Control and Blast Cleaning equipment.

Pangborn DUST CONTROL

STOPS THE DUST HOG from stealing profits

# Speed Reducer Selection *Made Easy!*




When speed reduction requirements are within the fractional through 85 hp range, there is no selection problem for the design, consulting or plant engineer.

He *knows* that Winsmith can meet his specifications *precisely* with the world's most complete line within this category. And even more important, he *knows* that recommendations from Winsmith's engineering representatives can always be counted on to be practical and unbiased. That's only natural with so large a variety of standard units to choose from.

As one-of-a-kind replacements in the plant, or in quantities to serve as components on new machines, standard Winsmith Speed Reducers are a certain solution where ratings must be within the range of: 1/10 to 85 hp, 1.1: ! to 50,000 : 1 ratio and 32 to 113,000 in. lbs. max. output torque.

50th Anniversary

Fully descriptive literature, which includes suggestions for simplifying and expediting selection, will be mailed at your request.

**WINSMITH**
**SPEED REDUCERS**

Member of AGMA


## • Keep Informed

### SKF's Plant Expansion Underway

Construction is underway in the $10,000,000 plant expansion, equipment, and machinery replacement program of SKF Industries, Inc. SKF is adding to its Philadelphia Plant No. 1, at Front St. and Erie Ave., a laboratory addition, a new building fronting on Pennsylvania R.R. to house finished stores, a bridge connecting main factory building with new addition. An addition is also being made to the Shippensburg, Pa., plant to step up the production of retainers. Expansion at the Philadelphia Plant No. 2, Tulip and Kennedy Sts., will provide new and larger heat-treating facilities, and increase manufacturing capacities for spherical and cylindrical bearings.

### Dravo Names Sales Engineer

The Dravo Corp. Machinery Div., Pittsburgh, Pa., has announced the appointment of Erwin S. Mason, Jr., as sales engineer for the Machinery Division in the Cincinnati, Ohio, territory. His office will be in the Southern Ohio Bank Building, Cincinnati, Ohio.

### Dixon Appoints Domestic General Sales Manager

Anthony J. Zino, Jr. has been appointed domestic general sales manager of Joseph Dixon Crucible Co., Jersey City, N. J.

Mr. Zino, formerly assistant to president of Swan-Finch Oil Corp., and a graduate of Case Institute of Technology, has had over 17 years of extensive experience in the varied phases of sales management.

### B & W Lease Area in Chrysler East

In one of the largest office leasing transactions in New York City in 1951, The Babcock & Wilcox Co., nation's largest producer of steam generators and related equipment, has taken five entire floors totalling approximately 120,000 sq ft of space in the new fully air-conditioned 32-story Chrysler Building East, New York.

### Nice Enlarges Plant

Nice Ball Bearing Company, 30th & Hunting Park Ave., Philadelphia, Pa., has recently completed additions to its plant. One addition will enlarge manufacturing space by approximately 9150 sq ft. The other addition, to be used for storage of raw materials, will cover approximately 5400 sq ft.

## • *LATEST CATALOGS*

### Centrifugal Refrigeration Data

Engineers designing comfort and process air-conditioning systems are given full capacity and design data for selection of centrifugal refrigeration units for the first time in a new CenTraVac bulletin No. DS-399, published by The Trane Co., La Crosse, Wis.

The new bulletin, contains information needed to select a centrifugal unit in the medium horsepower range, from 45 tons up. The bulletin describes the new CenTraVac, first hermetic centrifugal refrigeration unit with internal capacity control.

Diagrams, photographs, and charts illustrate the CenTraVac's automatic capacity control that assures efficient operation from 100% down to approximately 10% of rated capacity. In addition to complete selection data, mechanical specifications, and roughing-in dimensions, the 42-page bulletin outlines the CenTraVac's operating cycle and lubrication, purge, and control systems.

## • Keep Informed

### Production Plan-Book

In view of the current rapid increasing interest in methods and practices which will raise output per machine hour and man hour for both defense and essential civlian needs, Carboloy Dept. of General Electric Co., has issued a new plan-book showing how its "CCC" plan for co-ordinated tool control can be effectively used for increasing production and productive efficiency.

Essential operating details of the plan itself remain virtually unchanged, since the objectives of the plan always have been to insure obtaining (*a*) maximum production per machine, (*b*) maximum machine speeds, (*c*) maximum adherence to tolerances, (*d*) maximum tool life and minimum down time, (*e*) maximum pieces per tool, and (*f*) minimum number of rejects.

Under the revised approach to the plan, to meet current conditions, increased emphasis is put on factors which will help meet labor shortages, standardize on readily available tool styles and sizes, conserve scarce carbides and reduce rejects, in addition to increasing output.

Copies of the new plan-book are available to management men by writing to Carboloy Dept. of General Electric Co., Box 237, Roosevelt Park Annex, Detroit 32, Mich.

### Steam Traps

A new 24-page Bulletin No. T-1740, released by Yarnall-Waring Company, Philadelphia, Pa., gives information on the Yarway Impulse Steam Trap.

### Pumps

The following literature is available from Economy Pumps, Inc., Div. of Hamilton-Thomas Corp., Hamilton, Ohio: No. E-748 on General Service Sump Pumps; No. D-246 on the Type SCV Pump; No. C-349 on Split Case Multistage Pumps; No. F-1049 on Mixed-Flow Volute Type Pumps; No. C-351, Two-Stage Type DMD Pumps; No. A-750, Single-Stage Double-Suction Pumps; No. G-1050, Circulators by Economy; No. G-845, Horizontal and Vertical Axial-Flow Pumps; No. F-249, Vertical Non-Clog Open Shaft Pumps; No. E-345, Sump Pumps; No. D-151, Type Q Process Pumps; No. B-1146, $1^1/_2$-in., 5-Stage Type CS Vertically Split Case; No. F-447, Horizontal Non-Clog Pumps.

### Gas-Pipeline Pumping

A new two-color booklet on the G-E gas turbine for pipeline pumping has been announced as available from the General Electric Co., Schenectady 5, N. Y.

Designated as publication GEA-5530, the bulletin describes the features of the equipment, its application, and operation. It is illustrated with photographs, line drawings, and charts showing horsepower limits for various ambient temperatures.

A breakdown chart, showing the components of the turbine is also included in the publication, as well as sketches showing typical installation buildings.

Gas-turbine control, remote supervisory control, and accessories are also listed.

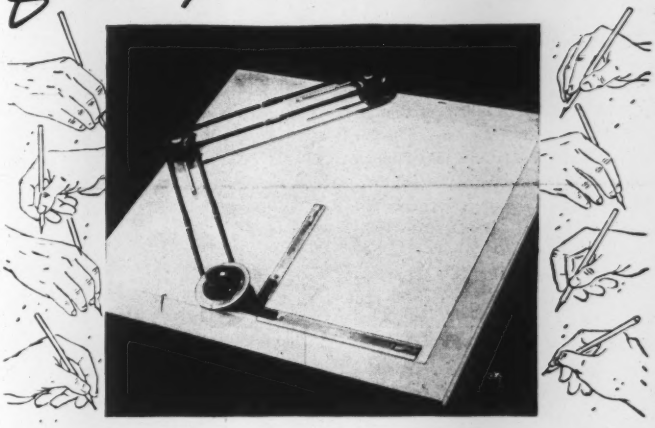
### Cottage Boiler

A new folder has been issued by Kewanee Boiler Corp., Kewanee, Ill., and describes the Kewanee cottage boiler for direct-fired domestic hot-water heating. This handy folder, designed for a dual purpose, may be used as a catalog reference bulletin, or as a direct-mail piece.

*Continued on Page 64*


# MORE WORK PER HOUR

*from Expensive Hands—*



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**This precise instrument, without which no drawing board is complete, combines into one accurate unit most of the loose tools of the drafting art — T-square, protractor, triangles, scales and parallel rules. It speeds all classes of work, improves its quality, and lessens operator fatigue.**

**This improved drafting machine in your plant will speed ideas to the blueprint stage — will cut engineering costs — will improve drafting room efficiency. Write for descriptive bulletin outlining the many exclusive features that have made Universal Boardmaster the favorite drafting machine of American industry.**

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DRAFTING MACHINE
DURALINE SCALES

# Wherever AIR or GAS is used Investigate STANDARDAIRE

## AXIAL FLOW BLOWERS

READ STANDARD'S engineered-for-production program has resulted in the acceptance of Standardaire Blowers for virtually every important industry. Blowers are currently being produced for a wide range of applications in a rapidly expanding market — and in many instances to suit specific requirements and specifications. The amazing acceptance of Standardaire Blowers is indicative of their superior operating characteristics, high efficiency and dependable performance in round-the-clock service. For further details we invite you to consult with our engineers. They will be glad to study your air or gas problems and make recommendations. Write Dept. E17

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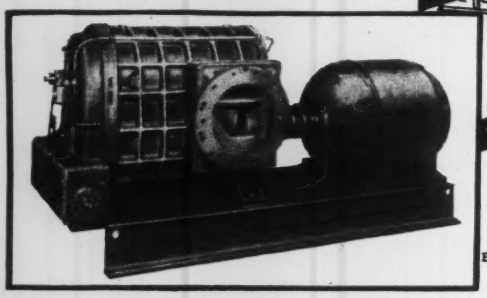

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Blower to deliver 2850 c.f.m.
at 1160 r.p.m.

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**BLOWER-STOKER DIVISION**

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The Standard Stoker Co., Inc.
ONLY THE NAME IS CHANGED

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CORPORATION

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## • Keep Informed

### Creep Stress Data

Technical information of value to engineers and designers associated with equipment operating at elevated temperatures and pressures is presented in a new data card published by The Babcock & Wilcox Tube Co., Beaver Falls, Pa. Known as TDC 102, it gives information on creep for a number of tubing steels. Creep stress data are given for rates of 1% elongation in 10,000 and 100,000 hr at temperatures from 800 F to 1500 F for 16 popular carbon, intermediate alloy, and stainless steels. Copies of the card are available free on request to the company's offices at Beaver Falls, Pa.

### Circuit-Breaker Panelboards

A new 20-page booklet, No. B-5260, describing circuit-breaker panelboards for the control and protection of lighting, appliances, and many other power applications—and the circuits that supply them—is available from Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

The booklet describes De-ion circuit breakers for a complete range of industrial and commercial requirements, in capacities from 10 to 600 amp.

### Chain Drives and Conveyers

A new bulletin entitled "Installation, Operation and Maintenance of Chain Drives and Conveyors" has just been published by Chain Belt Co., Milwaukee, Wis. Of great interest to all who design, install, maintain or operate chain drives and conveyers, this bulletin shows how to get the most service from your sprocket chains. The text is short and to the point, and most of the illustrations show graphically the correct and incorrect ways of solving chain installation operation, and maintenance problems.

### Magno-Therm Oxygen Recorder

Now available at the Hays Corp., Michigan City, Ind., is the functionally designed, fully indexed Magno-Therm oxygen recorder bulletin No. 51-829. Divided into five sections, it includes: (1) an introduction; (2) a complete, 3-color illustrated explanation of how an analysis is made utilizing the paramagnetic properties of oxygen; (3) a diagramatic explanation of the recording section's operation as well as detail photos and discussion of features such as voltage regulator, alarm contacts, slide wire, and cam unit, etc.; (4) the various gas sampling systems used with the instrument; and (5) chart-illustrated discussions of results obtained with the $O_2$ recorder in several installations.

### Alloy Steel Tubing

Assistance in solving problems involving the use of alternate grades of low carbon, or carburizing grades of tubing steels, is offered in a new 4-page bulletin No. TDC 149, published by The Babcock & Wilcox Tube Co., Beaver Falls, Pa. It presents condensed data on microstructure, critical points, effect of alloy elements, forging, machining, welding, and thermal treatment for 14 well-known alloy steels used in the production of tubular parts.

### Rotex Pumps

Warren Steam Pump Co., Inc., Warren, Mass., announce the availability of a new 8-page Bulletin No. WQ-50, covering Warren-Quimby Rotex pumps.

The bulletin illustrates and describes in detail this improved rotary type of pump, including both sectional and exterior views dimensions, selection chart, and specifications.

## • Keep Informed

### Stainless Steel Handbook

A new data and handbook on the stainless steels has been published by Allegheny Ludlum Steel Corp., Pittsburgh 22, Pa., and is now available for free distribution to users of the heat and corrosion-resistant metals.

In order to fill the growing needs of fabricators and design engineers for more complete on-the-job reference data, material contained in previous handbooks has been completely rewritten and categorized and much additional information has been added. In its 120 pages the cloth-bound volume discusses approximately 40 different types of Allegheny Metal stainless steel and covers each type from standpoints of analyses, fabrication, heat-treatment, and special conditions of service.

The first of seven chapters in the book is concerned with selecting the proper type of stainless for a given application. A selector table containing about 30 types, including both nickel-chromium and straight chromium steels, lists about 40 properties broken down in the general classifications of physical data, electrical properties, heat resistance, working and treating temperatures, mechanical properties and creep strength. A second group of tables in this chapter lists the corrosion resistance of the steels to the various media, including organic substances, acids and salts.

Subsequent chapters discuss each type of stainless separately and in more detail and supply specific information about heat treating, fabrication and certain special conditions in service. Separate chapters are given over to discussions of heat-resistant properties and low-temperature properties of the metals. Copies of the book may be obtained from the company's offices at 2020 Oliver Building, Pittsburgh 22, Pa.

### Steam and Air Traps

Armstrong Machine Works, Three Rivers, Mich., has recently issued a 12-page condensed catalog giving data and prices on Armstrong steam traps and air traps. The catalog lists cast semisteel and forged-steel inverted bucket traps, compound steam traps, ball float air traps, Y-type strainers, and internal check valves. There are four pages of data on calculation of condensate loads and selection of traps to handle these loads, including a full page for the Armstrong steam trap capacity chart. A parts list is also included for Armstrong cast semisteel and forged-steel inverted bucket traps.

### Single-Phase Inductrols

A new bulletin on G-E single-phase inductrols (low-voltage, dry-type induction voltage regulators) has been announced as available from the General Electric Co., Schenectady 5, N. Y.

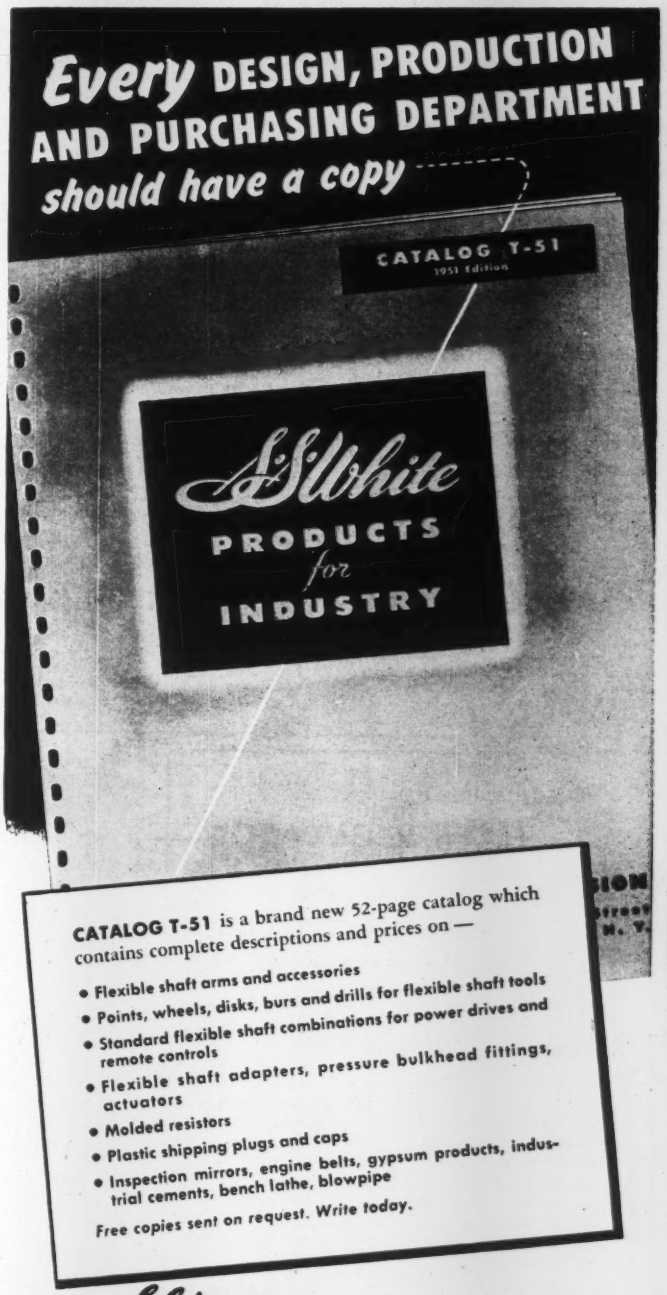
Designated as publication GEC-795, the bulletin describes the features of the redesigned inductrol equipment, its application, and operation. It also contains sketches, line drawings, and charts showing operating connections.

Complete price and purchasing data on the new line of equipment, rated 0.3 kva to 24 kva, for use in circuits rated 3 kva to 240 kva, is included in the bulletin.

### Bus Duct Manual

A new 68-page manual, No. B-4272A, describing types of bus duct and accessories available, and presenting application and test data, specifications, information on pricing a typical bus duct installation, and a typical bill of materials, is available from Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

*Continued on Page 66*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## • Keep Informed . . .

### Metal Turnings Crushers

American rolling ring metal turnings crushers are described in a new 8-page bulletin released by the American Pulverizer Co., St. Louis 10, Mo.

Many cost advantages are discussed in the pages, in addition to such technical data as capacities, speeds, power, clearance, and foundation plans. Space is also devoted to cutaway illustrations and complete descriptions of important construction features, including the now-famous rolling ring crushing principle—of which American is the originator.

### Pipe Hangers

Blaw-Knox Co., Pittsburgh, Pa., announces the availability of Catalog No. 51, covering pipe hangers, vibration eliminators, and supports. This catalog, issued by the Power Piping Division, contains valuable data for the use of those who buy materials of this character or write specifications therefor.

### Gas Burning Nozzles

The combining of a flame retaining nozzle and a long sweep elbow into a single unit, (patent pending) with advantages is described in catalog No. 804B, published by Hauck Mfg. Co., Brooklyn, N. Y.

The folder explains how the discharge orifice is displaced outwardly from the center line of curvature of the elbow. This design locates the orifice in the part of the mixture stream where there is the least difference in velocities. Therefore, the nozzle will operate with a lower manifold pressure without back firing, due to the consistent velocity across the full area of the discharge orifice.

### Reciprocating Pump

The Aldrich Pump Co., Allentown, Pa., has just released Data Sheet 67-A, a 2-color, 8-page bulletin, describing the Aldrich 6-in-stroke direct-flow pump series—recently added to the over-all Aldrich line.

Full details of design and construction, including dimension and sectional drawings, performance data, and pump specifications are given.

Applications for 6-in-stroke direct-flow pumps include: chemical handling, descaling systems, hydraulic systems, and oil field service.

### Vertical Boring and Turning Machines

American Steel Foundries, King Machine Tool Div., Cincinnati, Ohio, announces new 2-color catalogs, fully illustrated, containing complete description and specifications on King vertical boring and turning machines. Catalog K-1 covers machines sizes 30 in., 36 in., 42 in.; Catalog K-2, sizes 52 in., 62 in., 72 in.; Catalog K-3, sizes 84 in., 100 in.; Catalog K-4, sizes 120 in., 144 in. Please specify sizes of machines in which you are interested

### Swivel Joints

New catalogs and bulletins issued recently by Chiksan Co., Brea, Calif., include the following: 20-page catalog No. 50-D covering Chiksan ball-bearing swivel joints and fabricated products for the petroleum industry as well as for chemical and industrial applications; 4-page bulletin covering dimensions of Chiksan swivel joints; 4-page bulletin on packing sets for all Chiksan swivel joints. These catalogs and bulletins are available on request.

### Dynamometers

A new two-color booklet on G-E Type TLC (cradled), 250-volt, d-c dynamometers for direct-connection testing of internal-combustion engines, electric motors, pumps, blowers, and compressors, has been announced as available from the General Electric Co., Schenectady 5, N. Y.

Designated as publication GEA-5552, the bulletin describes the features of the equipment, its applications, and operation. It is illustrated with a number of actual installation photographs, a cutaway view of a dynamometer, a table of full-load horsepower and speed ratings, and a chart showing typical performance curves.

Dynamometer control and accessories are also listed.

### Economical Use of Steam

A new booklet consisting of 16 questions and answers regarding the economical use of steam is available from Sarco Co., Inc., New York, N. Y. For executives in the industrial and heating fields, it offers genuinely helpful information regarding the efficient use of steam.

### Package Cushioning

A laboratory equipped with the latest devices to render it of service to those facing problems in packaging costly and delicate equipment or equipment upon whose function lives depend, is being developed by Sponge Rubber Products Co., Shelton, Conn. In this connection, SRP has issued "Package Cushioning," a brand new booklet, which is believed to be the only thing of its kind produced by a firm engaged in the manufacture of package cushioning materials.


*An adjustable*

**FLOW REGULATOR**

**This newly perfected adjustable Flow Regulator holds at a constant rate even though the pressure fluctuates.**

**The valve controls adjustably in one direction and permits uncontrolled return flow.**

**The spring back piston in the housing is mounted in front of the adjustable screw. It carries a calibrated orifice, operates axially on change in inlet pressure so as to increase the throttling action.**

**Four sizes, ¼, ⅜, ½, and ¾ inch. Overall length, 4½ to 7½ inches. Adjustable over a 50% flow range. Maximum pressure is 3000 pounds.**

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**1.** STRONG electroforged construction for easy installation.

**2.** MAXIMUM OPEN AREA for light and air.

**3.** EASY TO MAINTAIN . . . paint reaches entire surface.

**4.** SELF-CLEANING, no sharp corners to clog.

**5.** SAFE footing at all times with twisted cross bar.

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# NEW TRANE BRAZED ALUMINUM SURFACE

## MORE HEAT TRANSFER EFFICIENCY

in $\frac{1}{4}$ the space

with $\frac{1}{3}$ the weight

at $\frac{1}{2}$ the cost

## A Smaller Unit Can Do A Bigger Job

More heat transfer from every cubic foot of space, more Btu's from every pound of surface, more Btu's per dollar—with the new Trane Brazed Aluminum Heat Transfer Surface.

Many of these Brazed Aluminum Units can pack *450 square feet* of heat transfer surface—working surface—into *one cubic foot.* That's up to *nine times* more surface than a shell-and-tube unit with ¾" tube can put into the same space.

In a given space, the units can meet practically any specifications of heat transfer, pressure drop, volume, number and direction of passes, and fluid velocity.

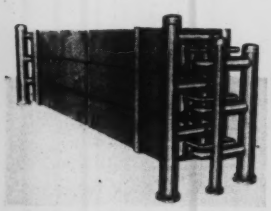
All aluminum, the units are much lighter than shell-and-tube heat exchangers—often needing only ¼ the weight to do the same job.

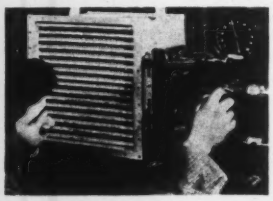
The units handle as many as five liquid or gas streams at once. Headers can be designed for any job.

Trane Brazed Aluminum Surface, evenly brazed in an exclusive flux bath process, is as rugged as it is flexible—it takes test pressures up to 1,000 lbs. per square inch, temperatures from −300°F. to 500°F.

Because they pack so much heat exchange surface into every cubic foot, and because of advanced manufacturing techniques, the units are much less costly than conventional equipment—a smaller unit can do a bigger job. *Trane Brazed Aluminum Units can often do the same heat transfer job as tubular exchangers that cost two or three times more.*

If you have a heat transfer job—one that demands a large number of units—Trane Brazed Aluminum Surface may be the answer. Contact your nearest Trane sales office, or write direct.





**Large units**—left, or small—at right, flexible Trane Brazed Aluminum Surface provides heat transfer efficiency.

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OFFICES IN 80 U. S. AND 14 CANADIAN CITIES

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*For heavy loads — light loads*
*high speeds — low speeds*
*static loads — shock loads*

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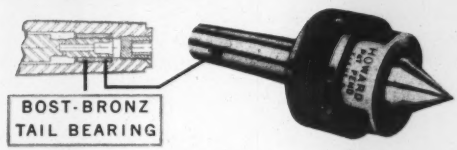
## *take heavy loads, for example:*



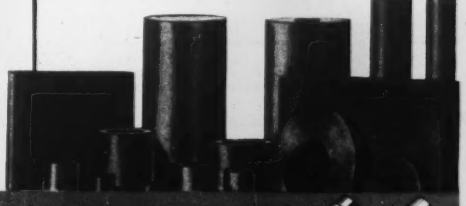

this *live-center* made by Melin Tool Co., Inc. of Cleveland, has been turning thirty ton turbine shafts for 15 months. The tail bearing is BOST-BRONZ. It's still as good as new! Frictionless and solid bronze bearings were tried but none would stand up under the terrific loads involved. BOST-BRONZ standardized, stock bearings proved the answer to years of searching for the right bearing.

STOCKED in a wide range of sizes in 6 types — cylindrical bearings, flange bearings, thrust bearings, cored bars, solid bars and plate stock.

## FIVE GREAT ADVANTAGES

BOST-BRONZ Bearings are

1. *better*—interchangeable with solid bronze but superior in performance.
2. *quieter* — an oil film to start on as well as run on.
3. *cleaner* — no oil drip or waste. No openings for grit, lint or dirt.
4. *easier to use* — no machining — simple press fits.
5. *more economical* — no oil holes or grooves to machine — longer service.



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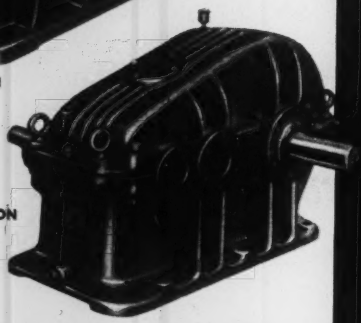
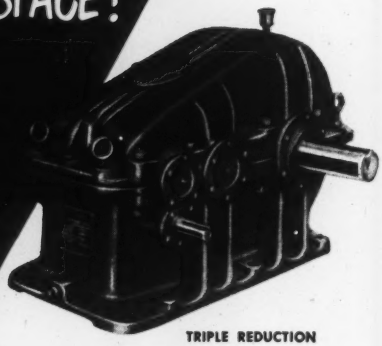


DOUBLE REDUCTION

# COMPACT

## MORE POWER IN LESS SPACE!



TRIPLE REDUCTION

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**MORE POWER — LESS SPACE** — Precision processed gearing, improved materials and heat-treatment, closer manufacturing tolerances, permit selection of smaller size, lower weight units.

**IMPROVED PERFORMANCE** — Generated helical gearing of maximum accuracy for uniform load distribution—positively located gearing for full tooth engagement across entire gear face—all mean better performance.

**SMOOTH OPERATION** — Overlapping tooth action of highly accurate helical gearing—close backlash tolerances—reinforced housing design plus extra capacity **Antifriction Bearings Throughout** provide smooth, quiet operation.

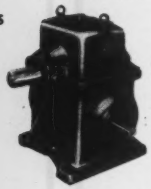
**42 SIZES** — Single, double and triple reductions, ratios from 2.08 up to 360 to 1—capacities up to 1,550 h.p. provide the correct unit for practically any application.

*A Foote Bros. enclosed gear drive for any industrial application. Foote Bros. will gladly consult with you on your enclosed gear drive requirements.*

LINE-O-POWER DRIVES

HYGRADE DRIVES

FOOTE BROS.-LOUIS ALLIS GEARMOTORS



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Send me Bulletin MPB on Foote Bros. Maxi-Power Drives.

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*Company*.....

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*City*.....*Zone*.....*State*.....

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*Controlled Quality*

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...to be sure of sound welds and fast assembly

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Keeping welding costs down to a minimum and erection schedules on time... these are important advantages you can assure to any piping job by installing Ladish Controlled Quality fittings. Metallurgical controls over materials and methods provide an assurance of uniform weldability in every Ladish fitting... and thorough inspection to rigid standards of physical dimensions and geometric accuracy assures fast piping assembly.

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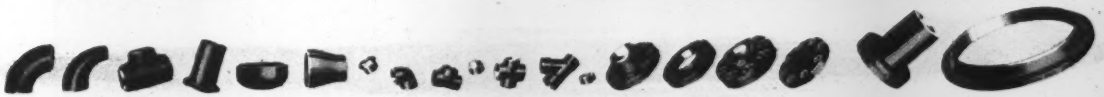
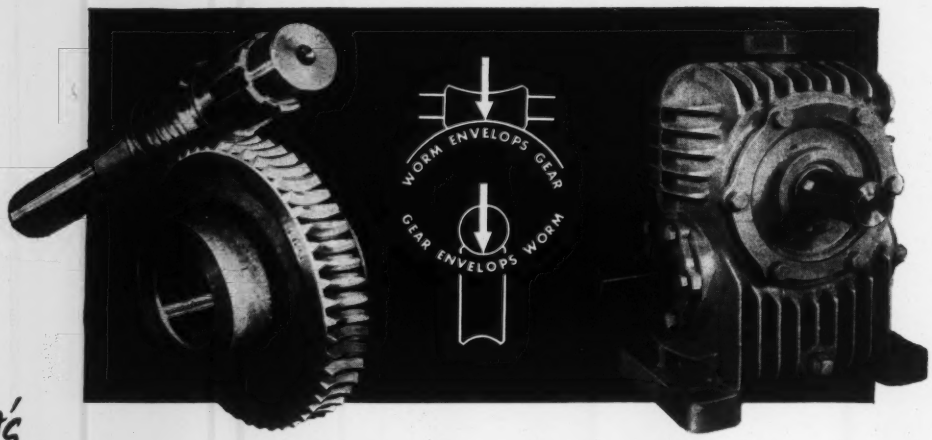





# *That's right*—"hydraulically smooth" gears!

**What we mean by "hydraulically smooth"**

It used to be thought that carbide-tipped milling cutters on milling machines had to be protected against carbide-damaging gear vibrations in the cutter drive by using large flywheels at the cutter head. When Cone-Drive double-enveloping gears were tried, their 'hydraulic smoothness' made the flywheels unnecessary.

Never heard of gears that are hydraulically smooth? Then you should try Cone-Drive DOUBLE-ENVELOPING gearing: In Cone-Drive gears, the pinion or worm is wrapped around the gear and the gear is wrapped around the worm in such a manner that

**regardless of number of teeth, gear size or ratio, ⅛ of all gear teeth are in CONTINUOUS CONTACT**

What is more, they are in continuous FULL DEPTH area contact. As a result, not only is power transmitted in a smooth uninterrupted flow AROUND THE CIRCUMFERENCE of the enveloped gear, but the load capacity for a gear set of any given center distance is greatly increased.

That means longer, trouble-free service, and the ability to use smaller gears to transmit a given load. As a matter of fact, Cone-Drive double-enveloping gears are so compact that many designers find they can simply

**replace costly built-in gear trains with complete standardized Cone-Drive speed reducers**

If you are looking for gears or reducers that will give you real hydraulic smoothness, greater load carrying capacity in a limited space, and a simpler gearing installation, fill in the coupon, attach to your company letterhead and mail it today.

**CONE-DRIVE GEARS**
**DIVISION OF MICHIGAN TOOL CO.**
**7171 E. McNichols Rd.**
**Detroit 12, Mich.**

Please send me without obligation further information on double-enveloping Cone-Drive Gears. We are particularly interested in the following:

Horsepower_____to_____

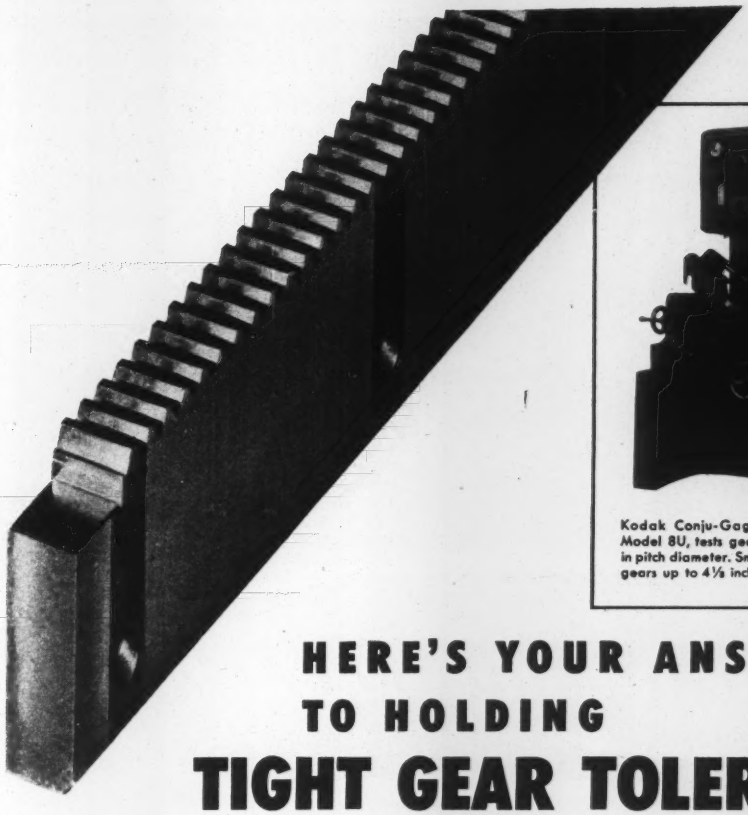
Ratio ____/1 to ____/1

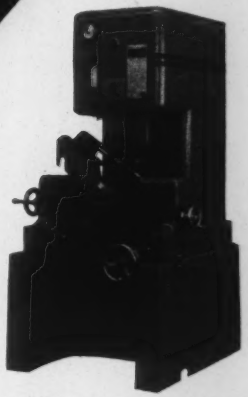
Name_____

Title_____

(attach to company letterhead and mail)

CONE-DRIVE GEARS
*Division Michigan Tool Company*
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan





Kodak Conju-Gage Gear Checker, Model 8U, tests gears up to 8¼ inches in pitch diameter. Smaller models check gears up to 4⅛ inches.

# HERE'S YOUR ANSWER TO HOLDING TIGHT GEAR TOLERANCES!

It's a new and better way to check precision gears. With the Kodak Conju-Gage Gear Checker, you can pass every right gear, reject every wrong gear—even to the closest tolerances you're asked to meet.

Here's how it works: The production gear revolves against a Kodak Conju-Gage Worm Section of inherently simple and accurate form. A single one of these sections is accurately conjugate to spur or helical gears *of any helix angle or any diameter* as long as they have the same normal pitch and pressure angle. You can check it by familiar toolroom methods and have it reground to its original specifications when your checks show the need to do so.

What's more, the Kodak Conju-Gage Worm Section is made to tolerances almost impossible to attain in circular master gears, especially in finer pitches. And it can be used to check taper and crown, as well as the composite effects of runout, base pitch error, tooth thickness variation, profile error, and lateral runout. Lead error in helical gears can also be checked.

The inherent certainty in Kodak Conju-Gage gear checking cuts unnecessary rejection losses while maintaining required precision. For detailed information, write for the booklet, "Kodak Conju-Gage Gear Testing Principle." Eastman Kodak Company, Industrial Optical Sales Division, Rochester 4, N. Y.

## CONJU-GAGE INSTRUMENTATION

*...a new way to check gear precision in action*

Kodak

# If you want authoritative information on *Moly-sulfide* as a lubricant

*Write for this booklet*

**Climax Molybdenum Company**
500 Fifth Avenue New York City

*Please send your* FREE *Booklet*
**"MOLYBDENUM DISULFIDE AS A LUBRICANT"**
BLOCK LETTERS PLEASE

Name .....

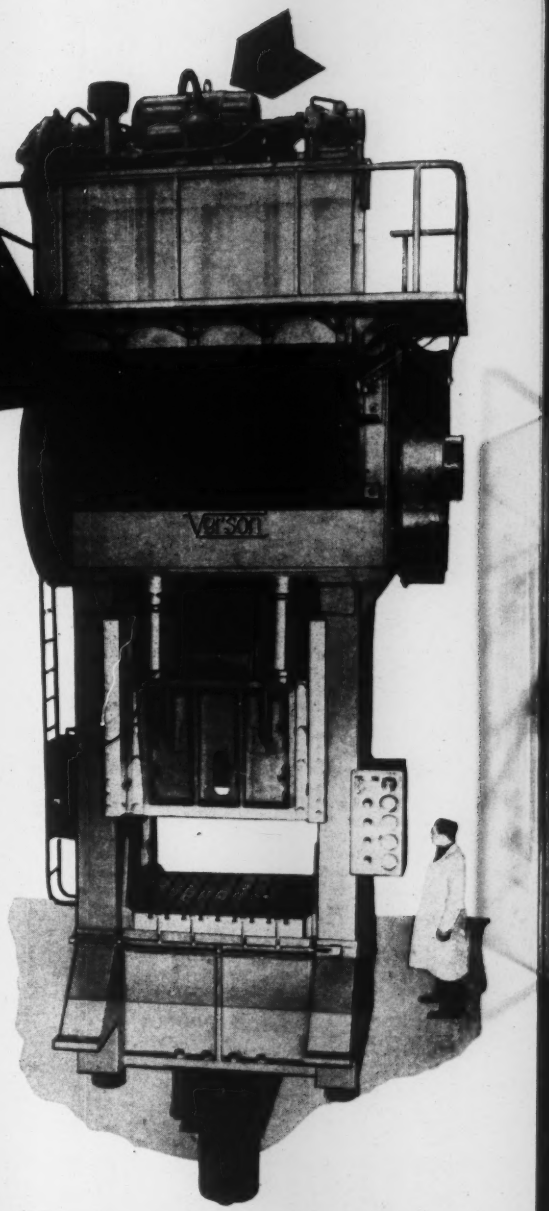
Position.....

Company .....

Address.....

MS 2 ME-9

# Machine with a POWERHOUSE PUNCH!




In one mighty blow, this giant 850-ton, double-action, deep-drawing Verson Allsteel press forms an intricate automobile part.

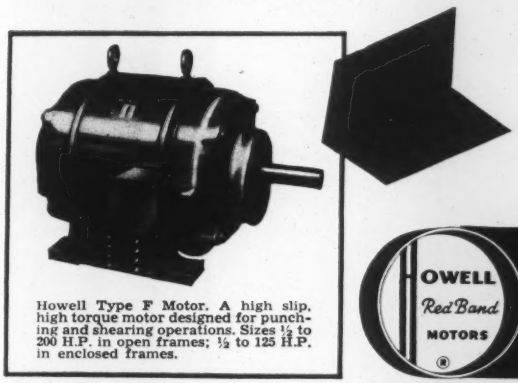
Multiply this by seven strokes a minute, 3 shifts a day, seven days a week and you have a rugged operating schedule . . . one which the Howell motors that power this fine press take right in stride.

Howell engineers worked closely with this manufacturer to select the *right* motor for each job. The main drive motor is a Howell 50 H.P. high slip, high torque motor designed specially for punch press work. The self-adjusting blankholder is driven by a hydraulic pump, powered by a 50 H.P. Howell motor. A 20 H.P. Howell motor operates another hydraulic drive.

Howell will devote the same care and attention to your electric motor problems and needs. With this cooperation and Howell quality, you're assured of motors that will stand up under the heaviest production load over long periods without interruption.

May we help you?

**HOWELL ELECTRIC MOTORS COMPANY**
**Howell, Michigan**



Howell Type F Motor. A high slip, high torque motor designed for punching and shearing operations. Sizes ½ to 200 H.P. in open frames; ½ to 125 H.P. in enclosed frames.

HOWELL Red Band MOTORS

HOWELL ELECTRIC MOTORS CO., HOWELL, MICH.
*Precision-built industrial motors since 1915*

# PRECISION TURNING POINTS

## for tiny shafts

For extremely small shafts in fractional h.p. motors, instruments, home appliances, cameras and projectors, Fafnir makes several series of *extra small ball bearings* . . . in metric bore sizes down to 4 mm and in inch sizes down to ⅛".

The advantage of these small bearings show up in several ways. For the portable converter illustrated, they assure instantaneous, dependable response no matter how long it has remained idle. Bearing lubrication is eliminated . . . under normal conditions. Shaft wear reduced to a minimum.

Fafnir Extra-Small bearings are available with standard, special or super-precision tolerances . . . in various constructions. They can be fitted with grease shields, Mechani-Seals or Plya-Seals.

**An important reference catalog**

The new Fafnir Instrument Ball Bearing Catalog provides valuable data on dimensions, load ratings, tolerances, mountings etc. Also information on ball bearing standards and illustrations of typical applications. Send for a copy. The Fafnir Bearing Company, New Britain, Conn.

# FAFNIR

## BALL BEARINGS

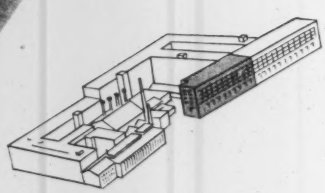
MOST COMPLETE LINE IN AMERICA

PROGRESS REPORT

### DOING OUR BEST

To try to keep abreast of an unprecedented demand for Fafnir Ball Bearings we're doing our best to provide greater production facilities.

One phase of this expansion program is the recently completed, 6-story modern addition to the main Fafnir Plant. It adds 70,000 square feet of manufacturing space to the 750,000 previously included in the 4 Fafnir Plants . . . now, almost 19 acres.



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*with the world's finest, largest selling*

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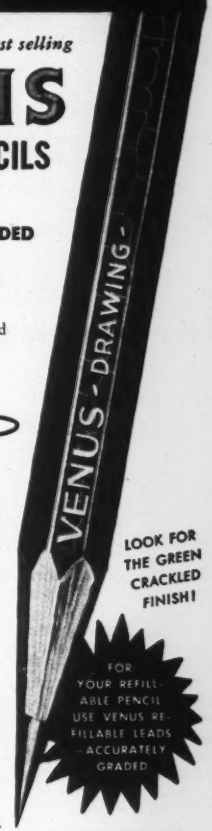
## DRAWING PENCILS

- **ACCURATELY GRADED** —in 17 degrees
- **STRONGER**—the lead is *Pressure-Proofed**
- **SMOOTHER**—the lead is *Colloidal* processed*

*Exclusive Venus patent

Uniform lines in weight and tone. Opaque lines for sharp, clear reproduction. Strong points, smooth in action. No smudge; no ghosts from erasures. There's the right degree for your favorite tracing papers. The result: sharper prints—*by any process!*

**DISPLAY VENUS** and you'll sell more pencils . . . make more profit. Venus is better known, more wanted. It sells itself!




LOOK FOR THE GREEN CRACKLED FINISH!

FOR YOUR REFILLABLE PENCIL USE VENUS REFILLABLE LEADS —ACCURATELY GRADED

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**AMERICAN PENCIL COMPANY**
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Please send me free Venus *Technical Test Kit* with two Venus Drawing Pencils in these degrees: ( ) ( ).

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*Company* .....

*Street* .....

*City* ..... *State* .....

# safe

## *in hazardous locations!*

**SARCO self-operated temperature control requires no "explosion-proof" equipment...**

Here is a neat and economical solution to the problem of providing accurate temperature control in hazardous areas.

Electric Controls as well as all wiring devices, relays and switches in such locations must be "explosion-proof." They are extremely expensive and not entirely fool-proof.

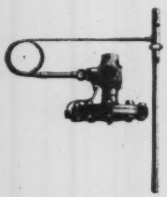
The engineers of a large metal fabricating plant in the midwest, for an extensive oil storage house, designed the system shown in our diagram.

Hot water, generated in a steam heated converter, controlled at the desired temperature by a SARCO regulator, is pumped through heating coils strategically arranged all around the room, and then back to the heater.

Each heating coil is equipped with a SARCO self-operated regulator with liquid-filled, extra sensitive thermostat, to provide modulated control.

Continuous circulation is maintained by equipping the last regulator on the line with a three-way diversion valve, so that a varying portion of the heating medium is by-passed without going through the coils.

*RESULT: Safe, extremely sensitive control of room temperature at a fraction of the usual cost.*



**Sarco Temperature Regulator, type 24-30 pilot-operated, single seated for positive shut-off on dead end service.**

**Catalog 601 contains full information on simple temperature controls for many other applications. Write for your free copy today.**

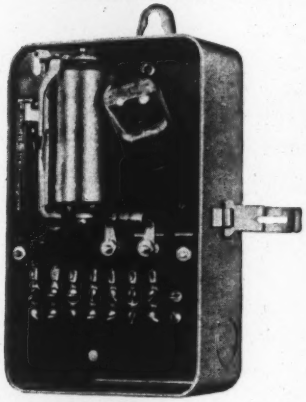
345

SARCO COMPANY, INC.
EMPIRE STATE BUILDING, NEW YORK 1, N. Y.
REPRESENTED IN PRINCIPAL CITIES

# ADD ELECTRONIC HANDS TO CUT COSTS ... *use G-E electronic equipment*

**Here are three basic time, money, and manhour savers that will give consistently accurate, dependable service and seldom require attention. There are few moving parts that are subject to wear, no special servicing needed. On many types of jobs, in many parts of your plant electronic hands will take over fatiguing, routine operations and assure you of silent, continuous service. Write now for the bulletins describing each type or ask the nearest G-E Sales Office for more information.**

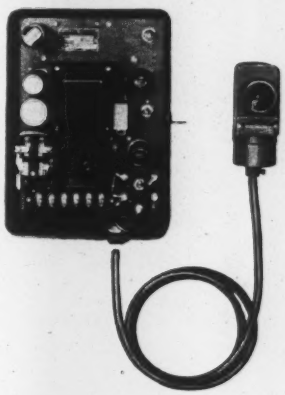
### ELECTRONIC RELAY



This is frequently used as a component in various processing systems. It can control a power circuit from a low-current or high-resistance contact on . . .

1. "stop-motion" mechanism of beamer reeling equipment
2. liquid level in storage tanks
3. contact-making instruments
4. operating a counter switch
5. sort small parts
6. test conductivity of solutions
7. counting insulation breaks in wire enameling
8. detecting jammed pieces in punch press dies

### PHOTOELECTRIC RELAYS



The five basic types listed here may be applied to many types of jobs. Their selection is determined by your requirements—frequency of operation, need for infrared light, etc. Here's what they'll do:

*Count*—objects on production line or conveyor; small items, freshly painted, fragile or hot objects.

*Control*—drinking fountains, automatic scales, car and bus washers, door-operating mechanisms.

*Signal*—elevators, garage and parking lot attendants.

*Indicate*—overtravel, level, obstructions.

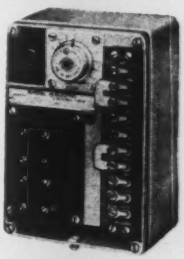
*Prevent*—pileups on production lines.

*Protect*—traffic control, shipping control in locks and harbors.

This simple timer has a dual set of contacts to permit control of two operations on same time schedule. Two modes of operation are possible. Easy to install and operate, has long life. It's used for . . .

1. timing paint spraying, car washing, photoprinting, electroplating, heat treating.
2. sequence timing of electric signs, bearing-grinding machines, rod coiling machines, commercial potato peeling machines, and centrifuges.

### ELECTRONIC TIMER



### CHECK THE BULLETINS YOU NEED

**General Electric Company, Sec. D 685-37**
**Schenectady, New York**

**Please send me information on these electronic devices:**

**Photoelectric Relays**

- ☐ GEA-3533 (operates up to 150 times a minute)
- ☐ GEC-275 (outdoor photoelectric relay)
- ☐ GEA-5255—Electronic Timer
- ☐ GEA-5034 (operates up to 300 times a minute)
- ☐ GEC-279 (operates up to 600 times a minute)
- ☐ GEA-4214—Electronic relay
- ☐ GEA-5339—Description of Industrial Electronics Training Course

NAME_____

COMPANY_____

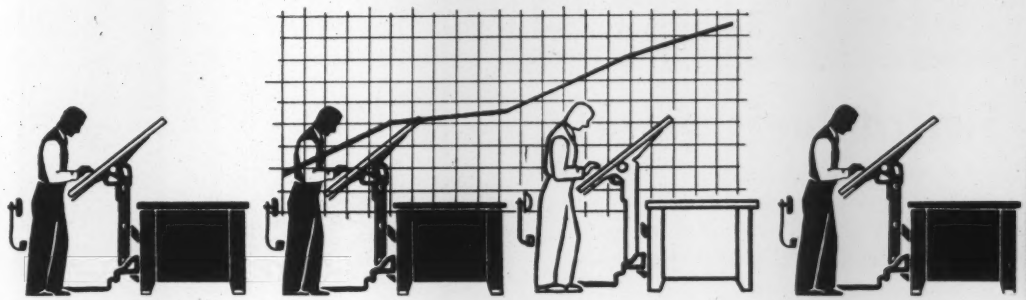
ADDRESS_____

**GENERAL ELECTRIC**

Where there's
Work
to be done!
There's a
Wallace
Barnes
Spring
to do it!
Bristol, Conn.

# When 3 draftsmen *must* do the work of 4

## *Hamilton Auto-shift* Tables are the answer!



Actual case histories offer proof that the installation of Hamilton *Auto-Shift* Tables brings drafting room production up, up, up. Why? Because *Auto-Shift* is the most *flexible* drafting table ever built. Instantly, effortlessly, your draftsmen can adjust this remarkable board to the most efficient, most relaxed working position. Fatigue goes down, productivity goes up!

**Drafting room miracles are being called for again!**

And how can you best answer the call? By adding skilled men if and when you can find them—and even more important, more practical—by increasing your daily output-per-man. And for mighty impressive proof that this can be done, contact your nearest Hamilton Dealer for a working demonstration of the Hamilton *Auto-Shift* Drafting Table.

Whether you have a D.O.-rating or not, see your Hamilton Dealer at once to insure earliest possible delivery.

HAMILTON WORK-DESIGNED DRAFTING EQUIPMENT

**Hamilton Manufacturing Company**

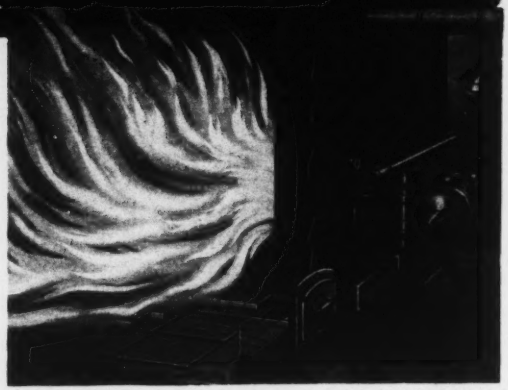
TWO RIVERS, WISCONSIN

# Iron Fireman Fires GAS, OIL or COAL in the same boiler

## Switch fuels quickly

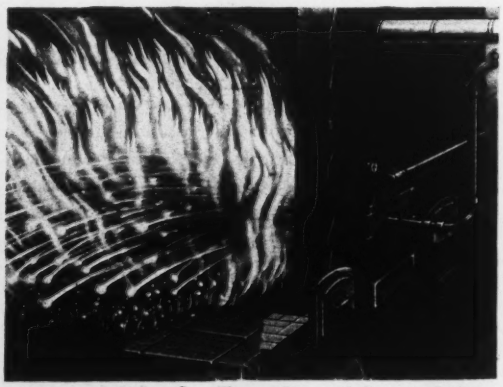
Iron Fireman combination gas-oil-coal firing enables you to guard your buildings or plants against seasonal or emergency fuel shortages or high fuel costs. Your boilers are equipped to burn whichever fuel is lowest in cost or most readily available, with quick changeover from one fuel to another. There is no sacrifice of efficiency, for all three burners are engineered for the job.

For further information write to Iron Fireman Manufacturing Co., 3151 West 106th Street, Cleveland 11, Ohio. Other plants in Portland, Oregon; Toronto, Ontario. Authorized Iron Fireman dealers throughout the United States and Canada.



**GAS** This typical combustion chamber is equipped for combination gas-oil-coal firing. The ring type gas burner is shown in operation. Coal feed nozzle has been removed and oil burner withdrawn from firing position

**OIL** The Iron Fireman rotary oil burner in firing position. For long periods of oil firing loose fire brick is laid over the coal grates. For short oil firing periods the usual layer of coal ash affords sufficient protection to the grates. Steady, even flame with low cost heavy oils. (Nos. 5 & 6.)



**COAL** Iron Fireman Pneumatic Spreader Stoker in gas-oil-coal equipped boiler. Coal is fed through pipe on stream of preheated air and is evenly distributed over grate area. Fines burn in suspension. Coal is automatically carried from bunker to fire.

**IRON FIREMAN**

***Automatic Heating and Power Equipment for Gas, Oil and Coal***

As the white outline indicates, a standard unit of much greater frame size would be required to do the work of Speedaire.

Speedaire-equipped agitator built by Buflovak Equipment Division, Blaw-Knox Company.

# SPEEDAIRE agitator drive saves $267

HERE'S another equipment builder who uses Speedaire because it is compactly designed, lighter in weight and lower in cost. Compared to the conventional worm gear drive required to operate this steam jacketed vertical agitator, Speedaire offers these advantages:

1. It occupies only one-third the space,
2. It weighs less than half as much,
3. It saves $267 per unit in cost.

Speedaire is Cleveland's fan-cooled worm-gear speed reducer. Because it is fan-cooled, Speedaire will do more work —will deliver up to *double the horsepower* of standard worm units of equal frame size, at usual motor speeds. It can be installed economically on many applications where other types have been used heretofore—giving you the advantage of a compact right-angle drive. Speedaire gives the same long, trouble-free service characteristic of all Clevelands.

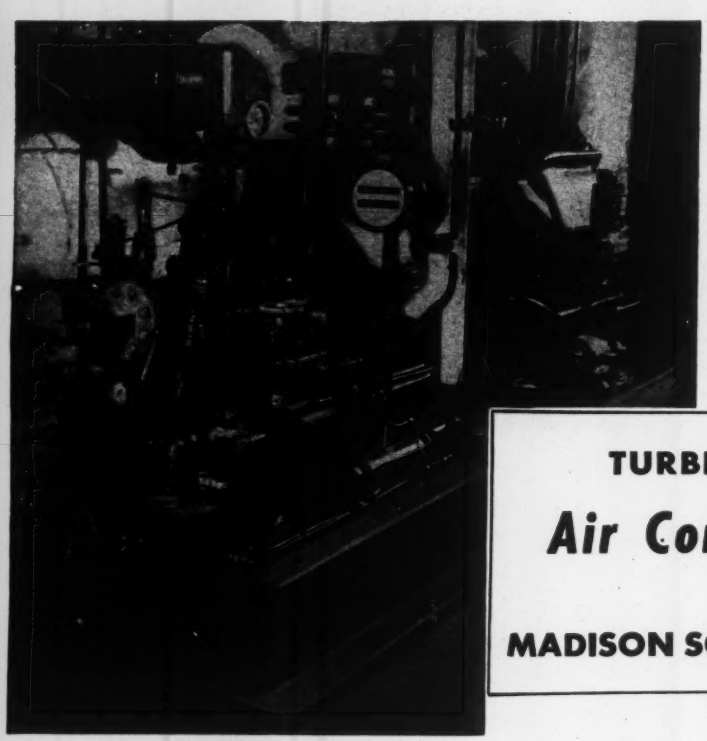
For full description, send for Catalog 300. The Cleveland Worm & Gear Co., 3264 E. 80th St., Cleveland 4, Ohio.

*Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.*

**CLEVELAND**

*Speed Reducers*

# The TERRY TURBINE



**TURBINES FOR**

## *Air Conditioning*

**AT**

**MADISON SQUARE GARDEN**

In 1925 Madison Square Garden installed three Terry Multi-Stage Turbines to drive air conditioning and refrigeration compressors. These units deliver 290 hp at 3500 rpm with steam conditions of 100 psi exhausting to a 26 in. vacuum.

After 22 years experience Madison Square Garden installed three more Terry Multi-Stage Turbines, one of which is shown above. This unit delivers 330 hp, at 5650 rpm, with steam at 100 psi exhausting to a 25 in. vacuum.

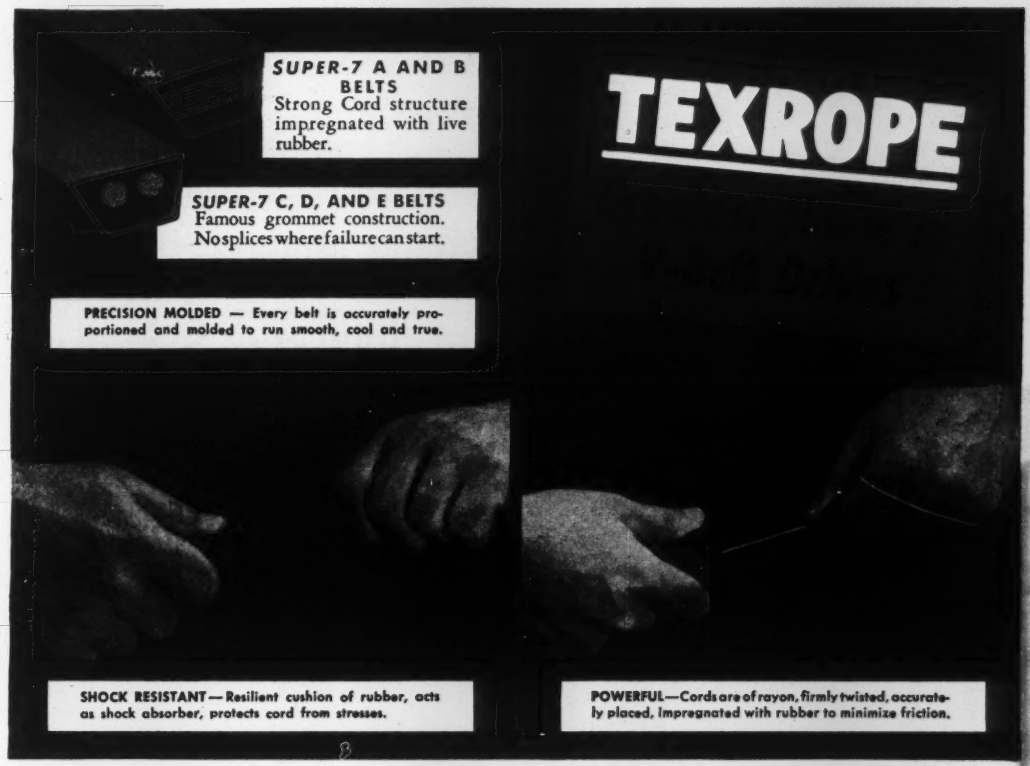
The same engineering talent and manufacturing facilities that produced these turbines are available to assist you in obtaining efficient power generation.

Any of our District Representatives will be pleased to give you full information on a turbine drive for your requirements. No obligation. May we send you descriptive bulletin?

TT 1184

**THE TERRY STEAM TURBINE COMPANY**

**TERRY SQUARE, HARTFORD, CONN.**


SUPER-7 A AND B BELTS
Strong Cord structure impregnated with live rubber.
SUPER-7 C, D, AND E BELTS
Famous grommet construction. No splices where failure can start.
PRECISION MOLDED — Every belt is accurately proportioned and molded to run smooth, cool and true.
TEXROPE
SHOCK RESISTANT — Resilient cushion of rubber, acts as shock absorber, protects cord from stresses.
POWERFUL — Cords are of rayon, firmly twisted, accurately placed, impregnated with rubber to minimize friction.

# *Cool Running*...LONG LIVED!

*SUPER-7* V-belts give long, satisfactory service even under bad conditions of load, shock and grit.

Tough, double-wrapped cover bias cut for elasticity and impregnated with rubber. Effectively seals out dust, grit, moisture; takes the wear; keeps the belt in shape; and protects cord structure.

But you get more than good belts when you standardize on *Super-7* V-belts. You also get the benefit of the greatest V-belt experience in the world both in the field and factory. You are assured of exactly the right drive for longest life from the wide variety of types and sizes available.

### High Capacity Belts

Where space is limited or other special conditions demand heavier duty, the high capacity belt can be furnished in A, B, C, D, and E sections . . . Extra strong cords, special rubber cushion and tough Neoprene cover give them 40% greater capacity than standard belts at proportionately higher price.

### V-Belt Drive Headquarters

Your nearby Allis-Chalmers Authorized Dealer or Sales Office can serve all your V-belt needs, whether they be new or replacement V-belts; standard and variable speed sheaves; or speed changers.

Get your copy of the revised 120 page *Texrope* Pre-Engineered Drive Manual from your A-C Dealer or Sales Office or write for Booklet 20B6956A. Allis-Chalmers, Milwaukee 1, Wisconsin.

A-3291

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by Allis-Chalmers Authorized Dealers, Certified Service Shops and Sales Offices throughout the country.

**MOTORS** — ½ to 25,000 hp and up. All types.

**CONTROL** — Manual, magnetic and combination starters; push button stations and components for complete control systems.

**PUMPS** — Integral motor and coupled types from ¾ in. to 72 in. discharge and up.

*Texrope* and *Super-7* are Allis-Chalmers trademarks.

# ALLIS-CHALMERS

# strain analysis improves design...

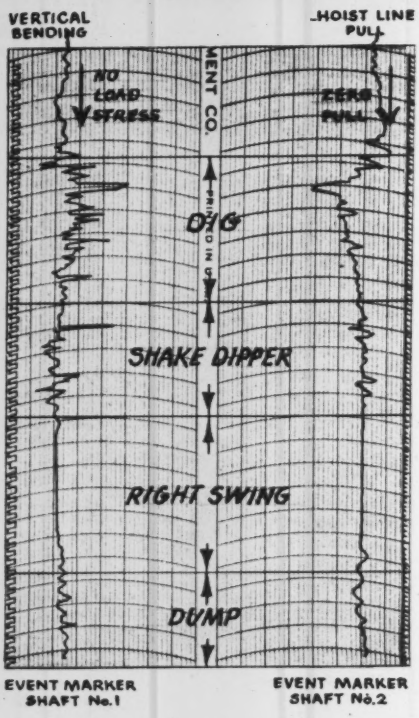
## BRUSH ANALYZER GIVES COMPLETE DATA...IN WRITING

● If the boom on an excavator is "over-designed", needless weight is added and steel is wasted. If the boom is "under-designed", failure may result.

That's why designers of the Marion Power Shovel Company get design facts from excavators in actual operation. With strain gages mounted on the boom, the hoist line pull on the shovel and the vertical bending of the boom are recorded automatically with a Brush two-channel Recording Analyzer. Event markers, recording on the same graph, indicate comparative rpm of different shafts.

Result—data not previously known has led to an improved design of Marion Excavators, and the saving of weight in the booms. Despite the severe operating conditions—for instruments—the Brush Analyzer continues to give satisfactory service.

It will pay you to investigate Brush Analyzers for studies of strains, displacements, light intensities, temperatures, surfaces, d-c or a-c voltages or currents, and other static or dynamic conditions. Write for full information. The Brush Development Company, Department P-13, 3405 Perkins Avenue, Cleveland 14, Ohio, U. S. A. *Canadian Representatives:* A. C. Wickman (Canada) Ltd., P. O. Box 9, Station N, Toronto 14, Ontario.



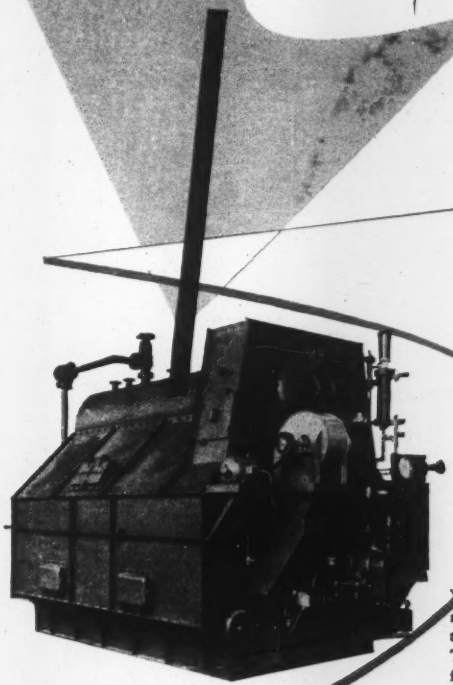

*Put it in writing with a*
**BRUSH RECORDING ANALYZER**

THE Brush DEVELOPMENT COMPANY

PIEZOELECTRIC CRYSTALS AND CERAMICS • MAGNETIC RECORDING • ELECTROACOUSTICS • ULTRASONICS • INDUSTRIAL & RESEARCH INSTRUMENTS

FOR EVERY INDUSTRY OR INSTITUTION

THERE'S A **WICKES**
STEAM GENERATOR
TO PRODUCE THE STEAM
YOU NEED



*Wickes shop-assembled Steam generator*

Wherever you are, whatever your steam generating needs may be, there's a custom-built Wickes boiler to suit your operation. For almost a century now, The Wickes Boiler Company has been leading the field in the manufacture of high-pressure boilers. Throughout the world, industries and institutions that depend on steam have learned by long experience that they can depend on Wickes. Wickes Boilers operate at a high degree of efficiency and owners' records show very modest maintenance costs. Wickes can fill your requirements for steam generators up to 250,000 lbs. per hour and 850 lbs. per square inch . . . all types of multiple drum boilers adaptable to any standard method of firing. Contact your nearest Wickes representative or write to our home office.

# WICKES

**THE WICKES BOILER CO., SAGINAW, MICHIGAN • DIVISION OF THE WICKES CORPORATION**

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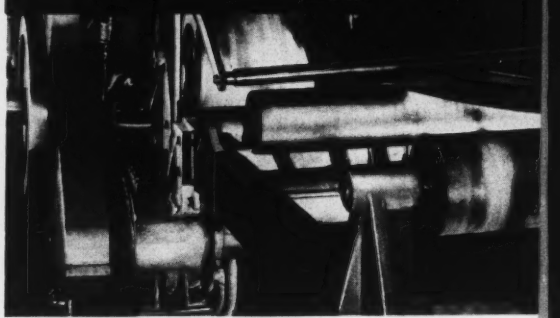
# Saves Time, Money, Material

ON CHICAGO CARTON COMPANY
LAMINATING MACHINE



AND CUT-OFF



## Oilgear drive installed in 1934 operates 16 hours daily at low cost. Gives maximum production on all stocks with little spoilage or non-productive time

A laminating machine and a cut-off in the plant of the Chicago Carton Company are driven in synchronism by Oilgear Fluid Power Equipment installed in 1934. A trip to the plant reveals today the compact, sturdy Oilgear equipment on the lower floor performing quietly, efficiently and continuously 16 hours a day in the necessarily humid atmosphere. Maintenance records indicate a total expenditure of $93.21 during the 16 years for service and parts, less than $6.00 a year. Because of the full flexible speed range and easy controllability of the Oilgear drives, the laminating machine is operated at speeds that best fit the type of board being processed and the cut-off drive follows in synchronism to cut stock into uniform lengths.

Another Oilgear feature important here is the unusual speed with which the laminating machine drive and cut-off drive can be started and stopped. This feature of Oilgear smooth, high speed acceleration and quick hydro-dynamic braking reduces non-productive time and cuts spoilage of sheets to a bare minimum.

On the basis of the 16 year performance of Oilgear, the Chicago Carton Company recently installed another Oilgear drive on a new 125 hp installation.

Time after time, Oilgear demonstrates its superiority and dependability on variable speed drives. Oilgear Fluid Power has many advantages. Investigate them now. THE OILGEAR COMPANY, 1570 W. Pierce St., Milwaukee 4, Wis.

**UPPER—Oilgear 40 hp Variable Speed Drive with electric pilot motor remote control and oil reservoir base.**

**LOWER—Oilgear 7½ hp Variable Speed Drive with automatic control to synchronize cutter speed with speed of laminating machine drive.**

# Oilgear

**PIONEERS IN FLUID POWER**

PUMPS, TRANSMISSIONS, CYLINDERS AND VALVES

NEW LINCOLN PLANT CREATED BY INCENTIVE-INSPIRED CO-ACTION IN DEVELOPING POSSIBILITIES IN PRODUCT

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## FLEXIBILITY IN MANUFACTURE MEANS LOWEST COST PER PIECE

**Products designed to utilize the economies of welded steel can be manufactured at lower cost regardless of quantity produced.** Any product design can be developed from an unlimited combination of steel shapes to suit the type of manufacturing equipment available.

Each of the tee sections shown has been designed to withstand equivalent loads. As quantities of production increase and brakes, shears and forming equipment become advisable, less material is, of course, required and the amount of welding itself can be reduced.

Your Lincoln Welding Engineer will gladly explain how your products can be simplified and fabricated at lower cost using welded steel construction. Simply write The Lincoln Electric Company, Cleveland 1, Ohio.



Fig. 3. Angles, brake formed from plate, have better dimensions to withstand loading. Section requires only light, intermittent welds. Costs 30% less than Figure 1.



Fig. 4. Tee section fabricated from light channel in automatic Lincolnwelded to plate cut to shape by high speed equipment. Gives better material distribution. Costs 35% less than Fig. 1.



Fig. 5. For higher quantity production, tee can be brake formed as a single piece from sheet and automatically Lincolnwelded at top. Weighs 30% less than Figure 1 . . . costs 40% less.

## the ACTUAL



Fig. 1. Tee section fabricated in small lots by welding standard angles back to back. Requires only hack saw and welder.

## increasing the YIELD



Fig. 2. Tee section for medium quantity lots for the shop having shear or flame cutting equipment. Costs 25% less than Figure 1.

## the IMMENSITY of the POSSIBLE

**Economical production regardless of quantity**

SEE HOW WELDED STEEL IS FABRICATED AT LOW COST

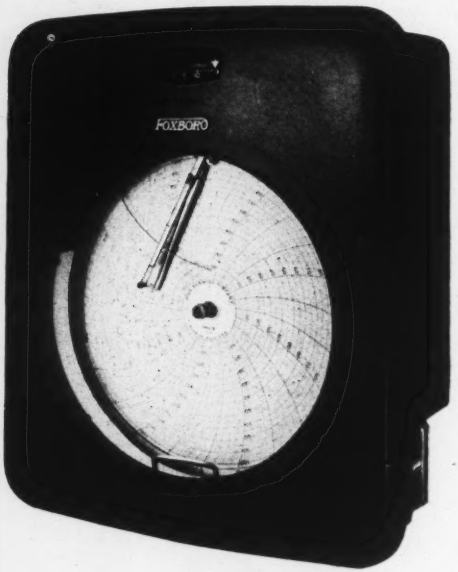
*Machine Design Sheets free on request to designers and engineers. Write on your letterhead to Dept. 403,*

## THE LINCOLN ELECTRIC COMPANY

**CLEVELAND 1, OHIO**

better measurement and control of

# LIQUID LEVEL

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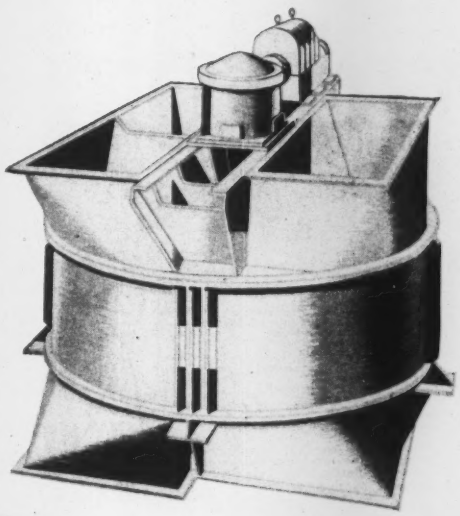
**To raise the level of heat recovery**

**To save materials in plant design**

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves the heat is transferred from the waste gases to the incoming cold air.



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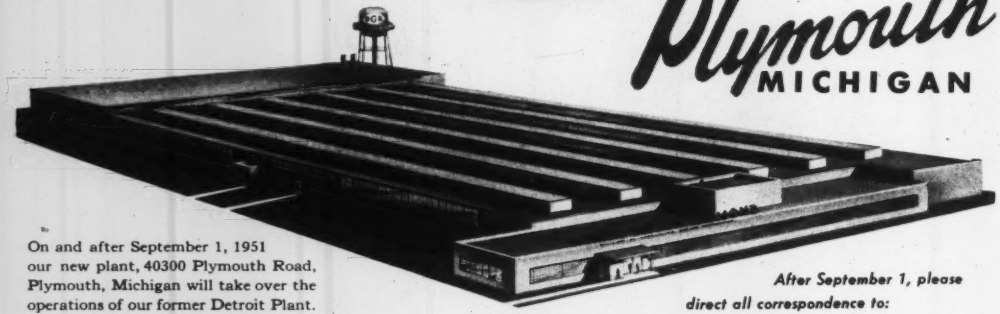

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## *A Note to Executives*

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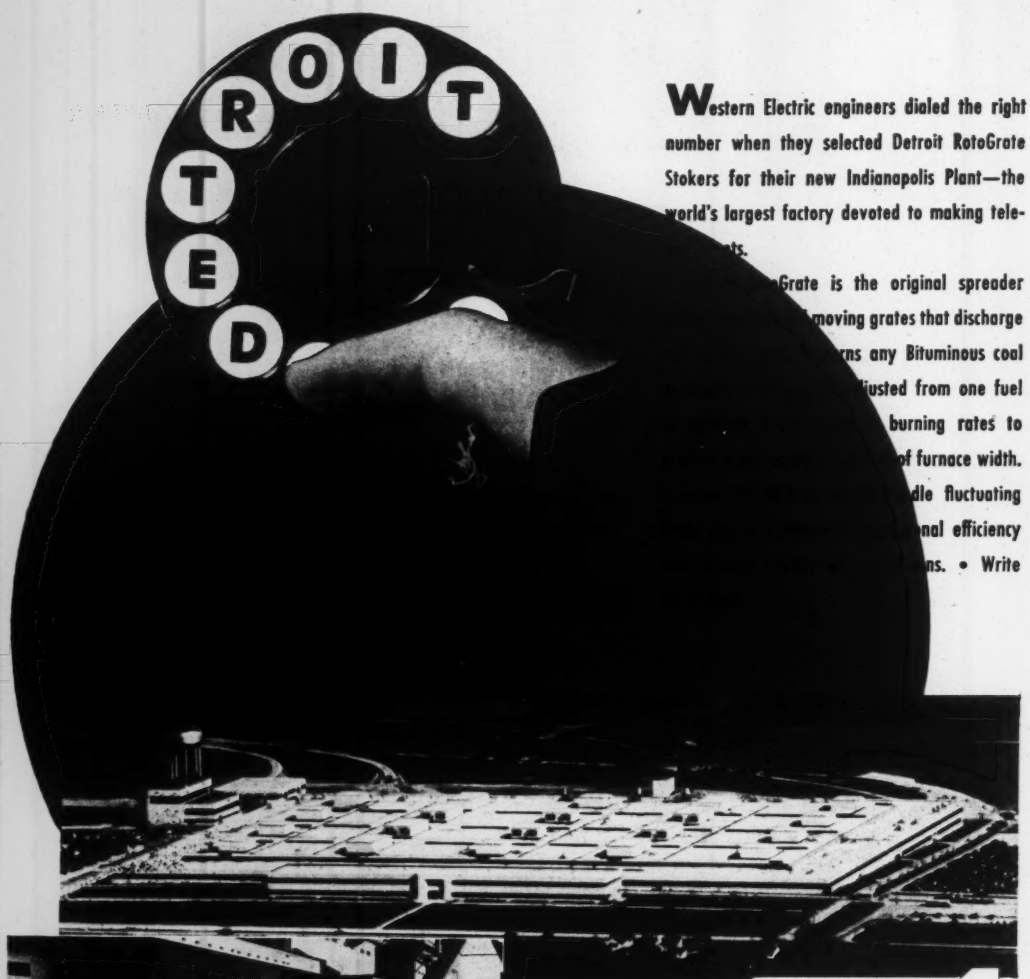


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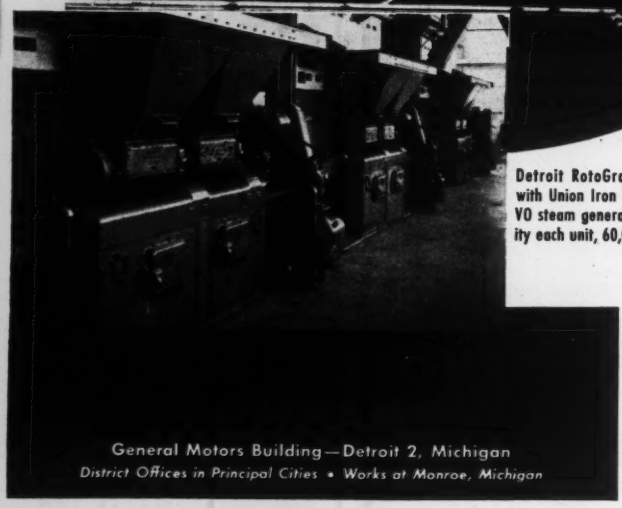

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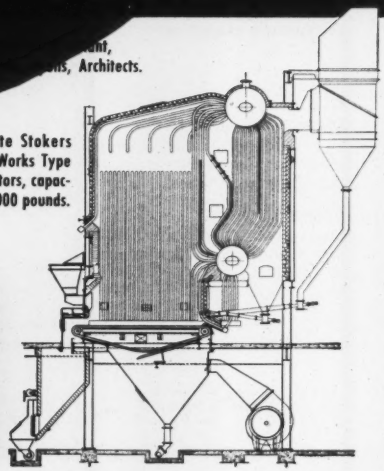
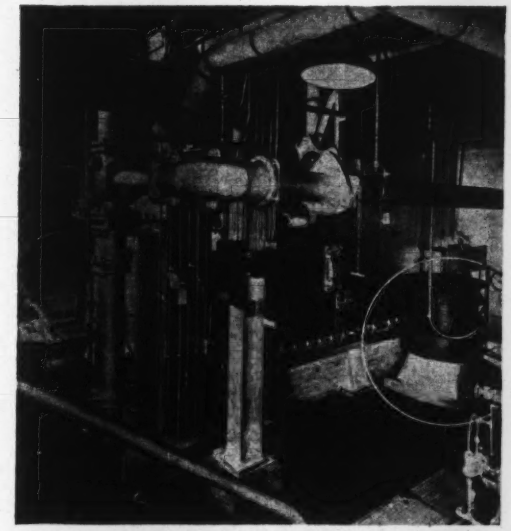
**Detroit RotoGrate Stokers with Union Iron Works Type VO steam generators, capacity each unit, 60,000 pounds.**





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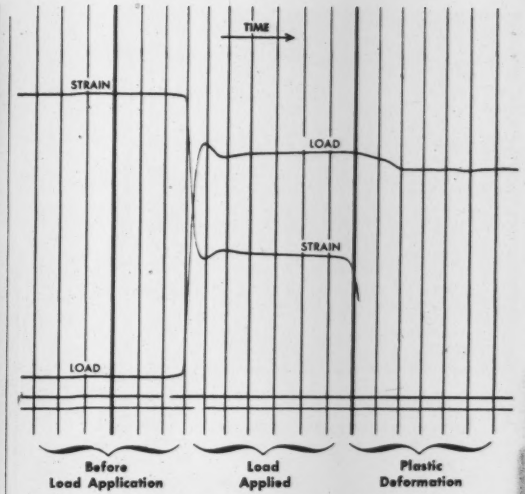


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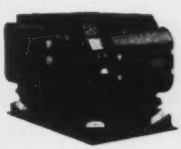

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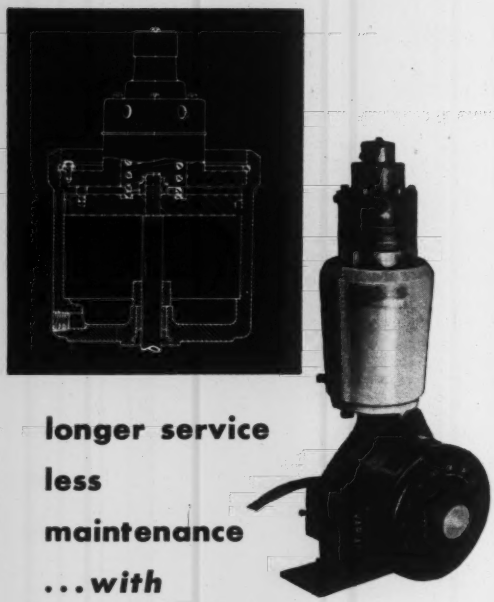

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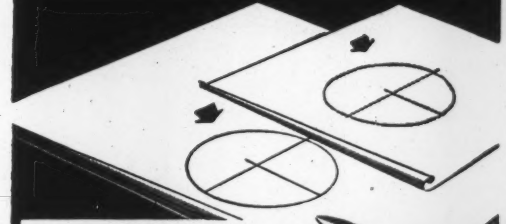

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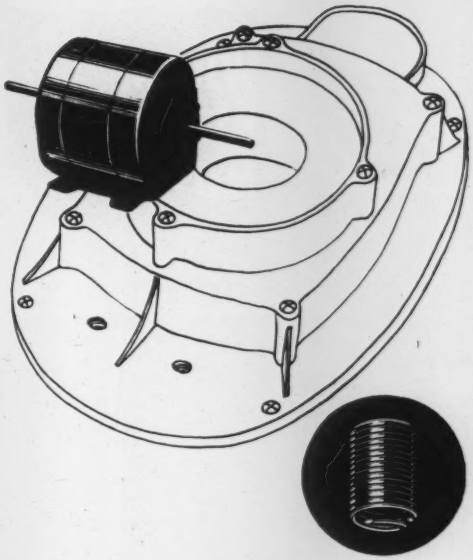

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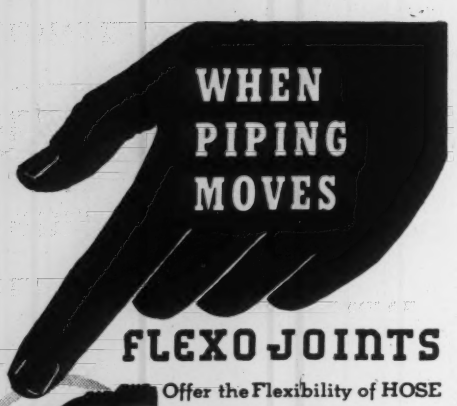


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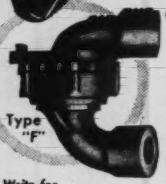


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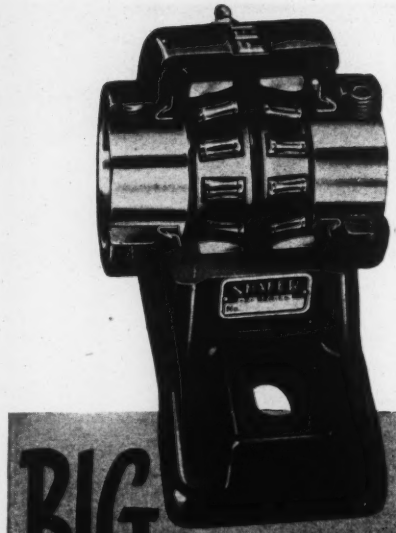

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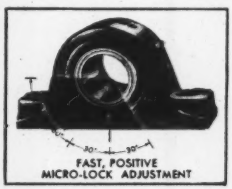

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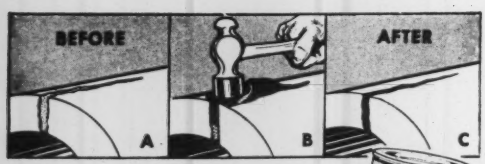


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| Rolled 1" and under | ..... | 75,000 | 65,000 | 60,000 | 50,000 | 45,000 |
| Rolled or Forged, over 1" | ..... | 75,000 | 65,000 | 60,000 | 50,000 | 45,000 |
| Elongation in 2"—% | | | | | | |
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| Forged or Rolled | ..... | 12 | 13 | | 15 | 20 |
| Reduction in area—% | | | | | | |
| Sand Cast | ..... | 12 | 14 | 15 | 20 | 25 |
| Forged or Rolled | ..... | 12 | 13 | | 15 | 20 |
| COMPRESSION | | | | | | |
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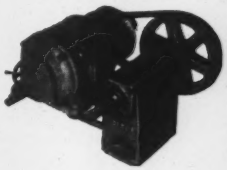

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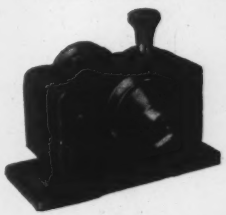

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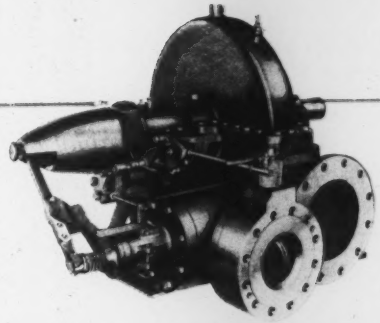

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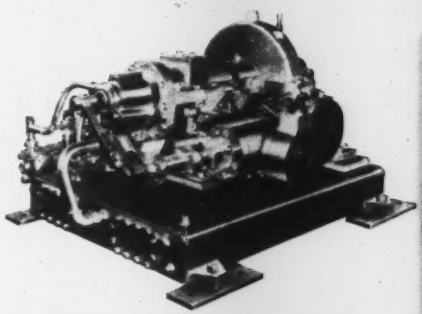

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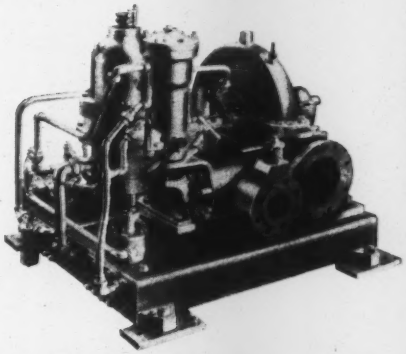

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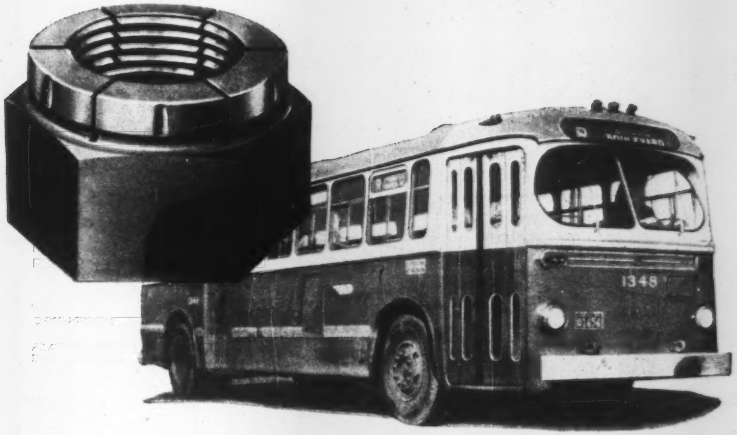

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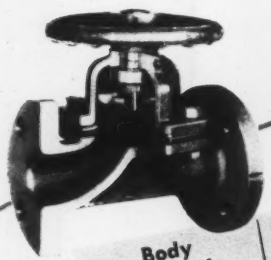

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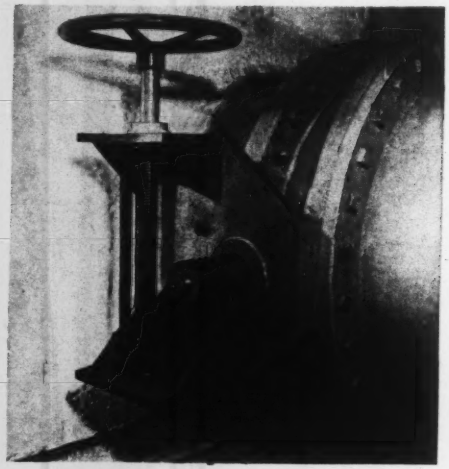

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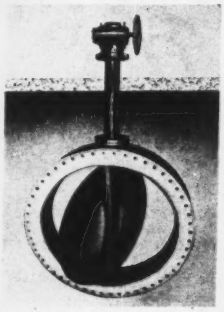

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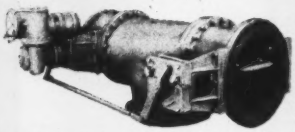

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### DESIGN ENGINEER

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# Eight Pages of "OPPORTUNITIES" This Month . . . 111-118

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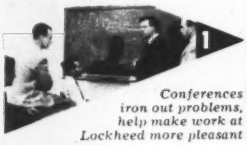

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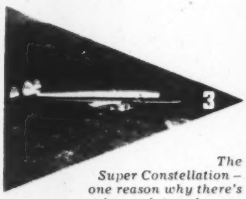

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**SECTION 4**

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Research, development, and production in nuclear technology, gaseous diffusion, and related fields.

Minimum educational requirement — B.S. degree, or its equivalent.

Salary commensurate with training and experience.

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STEAM POWER PLANT ENGINEER—with stationary or marine experience (operation and maintenance), for public utility in Central America. Write education, experience and salary expected. Address CA-3612, care of "Mechanical Engineering."

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## POSITIONS WANTED

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***appearing in this section each month.***

# Eight Pages of "OPPORTUNITIES" This Month . . . 111-118

## POSITIONS WANTED

*Continued from Page 117*

**Manufacturing Executive Available**
**Engineering Background**

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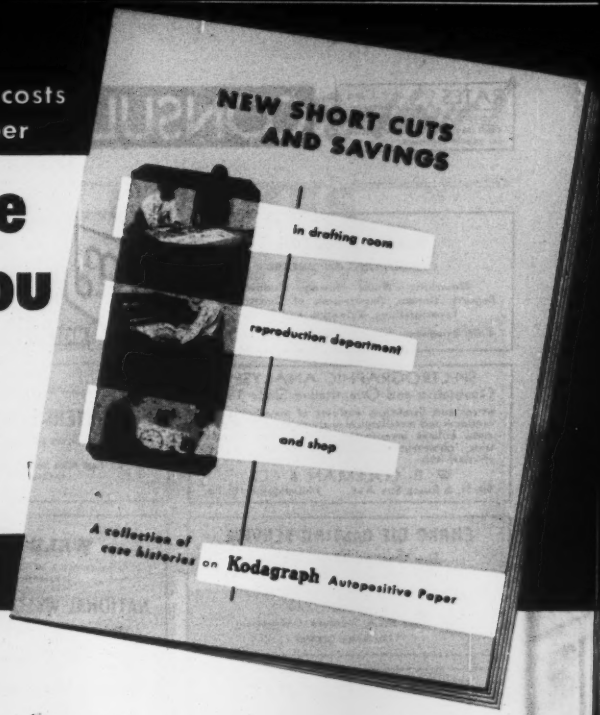
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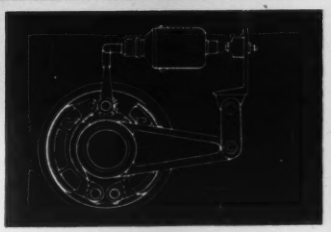

Railway track maintenance has to be quick, safe and positive. And the Pullman-Standard power track maintenance machines can crib, clean ballast, and tamp almost as many ties in an hour as a multiple-power-tool hand tamping gang can do in a day! These fast working machines need dependable brakes to stop and hold them in exact but continually changing work positions. And they have them! They're equipped with sturdy, TDA "P" Series Power Brakes. The simple design of these efficient brakes provides positive action—easy, low-cost maintenance.

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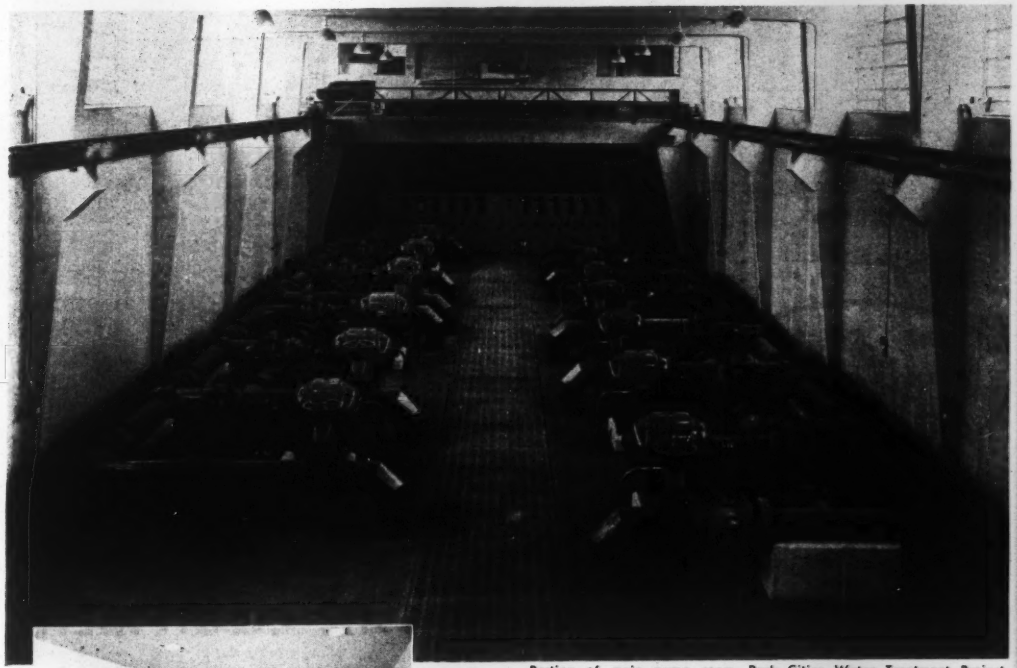
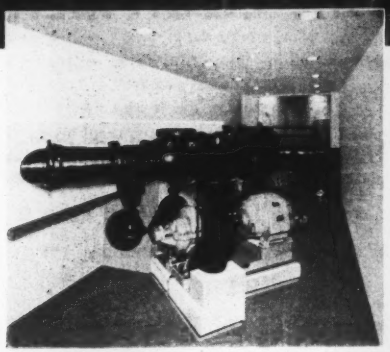


Portion of main pump room, Park Cities Water Treatment Project. Shown are 13 of the 22 Economy Pumps installed on this project.



View in University Park Booster Station, part of the Park Cities project. These Economy Pumps boost the pressure going to the overhead storage tank, located 5 miles from the treatment plant.

## in new Park Cities, Texas, Water Treatment Plant

Economical operation over a period of years was a primary requisite of the pumps for Park Cities Water Treatment Project, Dallas. In selecting pumps, Powell & Powell, Consulting Engineers, drew up specifications which took into consideration cost of equipment, efficiency of each unit and efficiency of units operating in series, plus rigid structural requirements and refinements of mechanical detail. Under this very exacting evaluation formula, Economy Pumps, designed especially for water works service, supplied by the Lone Star Pump and Machinery Co., were selected, on the Dallas County project.

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**CLARAGE FAN COMPANY**

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FROM ZERO TO FULL LOAD
ARMSTRONG TRAPS
DON'T PASS STEAM

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When there is a condensation load, the operation is the same except that the trap remains open until all condensate flowing into it is discharged.

Freedom from steam loss saves fuel, keeps down back pressure in return lines. Call your nearby Armstrong Representative for the traps you need now.

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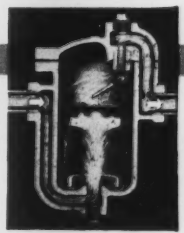
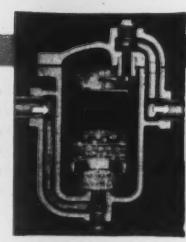
**OPEN**

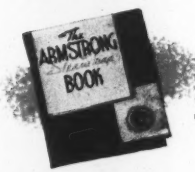
When accumulated water causes bucket to lose buoyancy, trap opens wide.



**CLOSED**

After condensate is discharged, steam entering bucket causes it to float, closing the valve tight. Valve remains closed until steam condenses.



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# ARMSTRONG STEAM TRAPS

# How to keep a table stable ...with TIMKEN® bearings

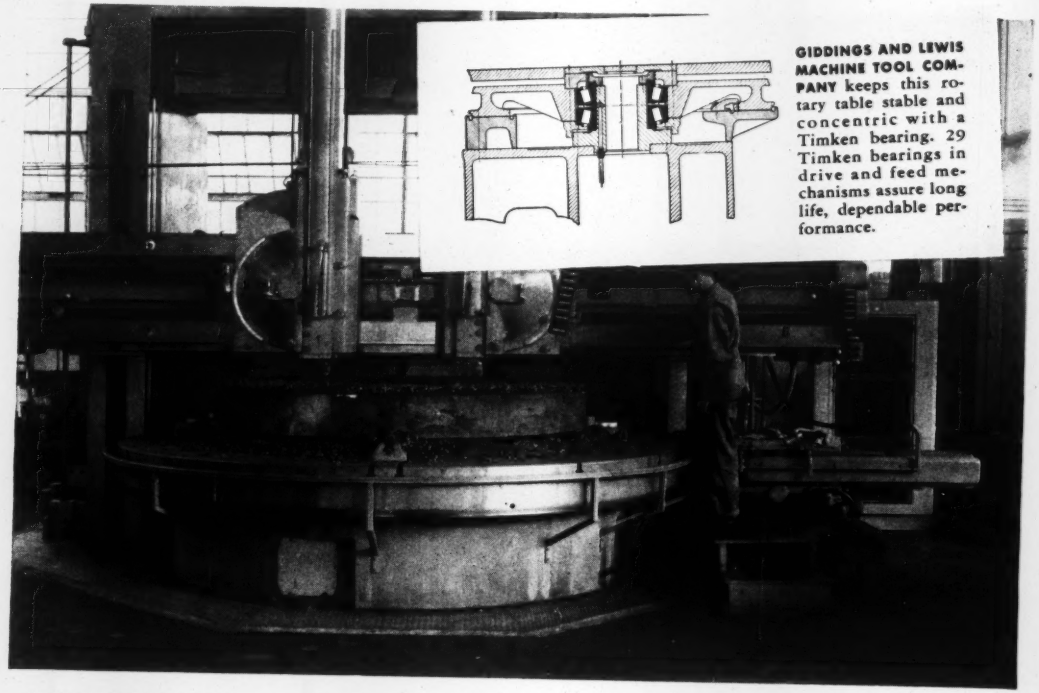
THIS Giddings and Lewis Hypro boring mill bores out castings up to 12′ in diameter and trims the OD at the same time. To assure concentricity, and to carry the heavy loads, the table shaft is mounted on a large Timken® bearing. 29 Timken bearings in the drive and feed mechanisms give the mill long life and dependable performance.

Timken tapered roller bearings take radial and thrust loads in any combination. Shafts are held in positive alignment with no deflection. Gears mesh accurately and wear on moving parts is kept to a minimum. Line contact between the rollers and races gives Timken bearings extra load-carrying capacity.

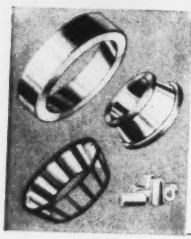
Timken tapered roller bearings are precision products throughout. Rollers and races are made of Timken fine alloy steel for toughness, then case-hardened for exceptional resistance to wear. True rolling motion and the incredibly smooth surface finish result in virtually friction-free operation. And because Timken bearings permit tighter closures, lubrication time and material costs are greatly reduced.

For over half a century, Timken bearings have been first choice throughout industry. If you build machine tools, specify Timken bearings. And if you buy new equipment, look for the trade-mark "Timken" on the bearings. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

*This symbol on a product means its bearings are the best.*



**GIDDINGS AND LEWIS MACHINE TOOL COMPANY** keeps this rotary table stable and concentric with a Timken bearing. 29 Timken bearings in drive and feed mechanisms assure long life, dependable performance.



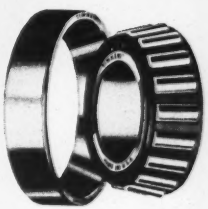
**DESIGN LEADERSHIP**

The first Timken tapered roller bearing was produced in 1898. Since then the one-piece multiple perforated cage, wide area contact between roll ends and ribs, and every other important tapered roller bearing improvement have been introduced by The Timken Roller Bearing Company.

The Timken Company leads in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis steels.

**TIMKEN**

***TAPERED ROLLER BEARINGS***



NOT JUST A BALL ○ NOT JUST A ROLLER ⊂⊃ THE TIMKEN TAPERED ROLLER ⊂⊃ BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION